Project Final Report
Farm Pond Green Infrastructure BMPs
319 Nonpoint Source Pollution Grant Program
Project Number: 17-02-319

March 2017 – June 2019
City of Framingham

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Prepared For:

Massachusetts Department
of Environmental Protection,
Bureau of Water Resources

US Environmental Protection Agency
Region 1

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Table of Contents

A. Project snapshot

A1. **Project start date:** March 2, 2017
A2. **Date closed:** June 30, 2019
A3. **Basin and HUC-12 watershed location:** Concord (SuAsCo) watershed
A4. **Segment and waterbody information:** Farm Pond (MA82035_2008)
A5. **Status of Waterbody:** Category 5
A6. **Priority pollutants targeted:** Sediment, Nutrients
A7. **Estimated annual pollutant removal, and method of determination, and calculations:**
N: 40 lbs/year
P: 9.3 lbs/year
Sediment: 6,725 lbs/year
Bacteria: Not calculated
Other: Not applicable
Method of Determination and calculations: Simple Method (calculations in Attachment 2)
A8. **BMPs installed, number and type**: One raingarden, one bioretention swale, and two water quality BMPs (stormceptors)

B. Project Summary

Project Title: Farm Pond Green Infrastructure BMPs
NPS Category: Resource Restoration
Investigator: City of Framingham, MA
Location: Farm Pond sub-basin in Concord (SuAsCo) watershed
Targeted Pollutants: Sediments, Nutrients

Description:
Farm Pond, an 860 acre sub-basin located in historic downtown Framingham is listed on the 2014 Integrated List of Waters as a Category 5 Waters, "Waters requiring a TMDL," for turbidity and excess algal growth. Stormwater runoff was identified in the Town's Stormwater Master Plan as the main contributor of pollutant loading and inability to meet water quality standards. As such, the Town will retrofit existing drainage features at Farm Pond Park and Fountain Street.

Project Goals:
Reduce sediment and nutrient loading to Farm Pond through the installation of stormwater BMPs at two sites. The secondary goal is to increase public awareness of the benefits of green infrastructure.

This project installed water quality and green infrastructure BMPs to reduce sediment and nutrient loading into Farm Pond. The project focused on improving water quality at two of the eight stormwater outfalls that discharge directly to Farm Pond. The Fountain Street BMPs focused on the drainage system that discharges into the lower southwest corner of Farm Pond. Two stormceptors were installed in the drainage system along Fountain Street. The Farm Pond Park BMPs focused on the drainage system around Farm Pond Park and the City's new skatepark and multi-use path on the western shore of Farm Pond. Existing stormwater BMPs were retrofitted to bioretention features in conjunction with the installation of a new rain garden at the new skatepark.

Results: Estimated annual pollutant removal of 6,725 lbs/year of TSS, 40 lbs/year of total nitrogen, and 9.3 lbs/year of total phosphorus.

Project Cost: $310,000

Funding: $185,000 by the US EPA
$125,000 by the City of Framingham

Duration: 2017 - 2019

C. Financial Summary

The proposed contract budget and final completed project budgets are included as **Attachment 1**.

The City revised the design of some of the BMPs, which resulted in higher consultant fees and higher construction fees than originally planned or approved with the grant. The City covered the additional costs and therefore, the City's match was higher than originally proposed.

Match Documentation. The match was a combination of in-kind labor from City staff and volunteers, consultant fees, and construction fees.

The City used approved capital improvement projects for the majority of the matching funds. The skate park and Fountain Street roadway & utility improvement projects had been approved and funded by the City independently of the grant. The grant funding allowed the City to upgrade these projects to include water quality improvements, which were not previously included in the projects' scopes of work.

D. Description of BMPs

This project installed water quality BMPs within the sub-basin to reduce sediment and nutrient loading into Farm Pond, focusing on improving water quality at two of the eight stormwater outfalls that discharge directly to Farm Pond. The BMPs provide an estimated sediment load reduction of approximately 6,725 lb/year, phosphorus load reduction of approximately 9.3 lb/year, and nitrogen load reduction of approximately 40 lb/year. (Calculations for pollutant load reductions are included in **Attachment 2**)

Green Infrastructure at Farm Pond Park

The Farm Pond Park BMPs focused on the drainage system around Farm Pond Park and the newly installed skatepark and multi-use path. Specifically, an existing outfall and drainage swale at the skatepark was retrofitted into bioretention areas. Additionally, a rain garden was incorporated into the landscaping at the skatepark. The location of the BMPs are shown in the figures and photographs are included in **Attachment 3.**

D1. **Type of BMP:** bioretention swale and raingarden
D2. **Date of implementation**: April 2018 – June 2018
D3. **Size of treatment area**: 3.6 acres
D4. **Area land use**: Residential, transportation, & recreation
D1. **Pollutant load removed**: 1,325 lbs/year TSS, 2.5 lbs/year TP, 11 lbs/year TN
D5. **Method of determination and calculations**: Simple Method (calculations in Attachment 2)
D6. **Signed statement**: Included as Attachment 8

Water Quality BMPs along Fountain Street

The Fountain Street BMPs focused on the drainage system that discharges in the lower southwest corner of Farm Pond. A combination of bioretention swales, rain gardens, and a pervious pavement sidewalk was proposed in the grant application at the corner of Winter Street and Fountain Street near the entrance of the Keefe Regional Technical High School. This project would have complimented recent work by MassDOT to improve the Winter Street bridge over the railroad just to the south of the intersection and utility and roadway improvements planned by the City of Framingham Public Works. The bridge, utility and roadway work, which included drainage and outfall improvements, was delayed. As a result of the delays and other extenuating circumstances, the Public Works could not come to an agreement with Keefe Technical High School about the proposed green infrastructure design and schedule. Therefore, the Public Works proposed a new BMP design to accomplish the same pollutant reduction goals but could be completed on City-owned property as part of scheduled roadway work in Spring 2019. Specifically, the City retrofitted existing drainage along Fountain Street and included two Stormceptor units along Fountain Street to provide water quality improvement.

Although Stormceptors are less efficient at removing pollutant loads than bioretention areas, the revised project area enabled the City to capture a larger drainage area with more impervious area than the original conceptual design. Therefore, the pollutant load removed was actually larger than the originally proposed BMPs.

D2. **Type of BMP:** proprietary structural water quality BMPs (two stormceptors units)
D3. **Date of implementation**: April-June 2019
D4. **Size of treatment area**: 5.9 acres
D5. **Area land use**: Residential, road
D6. **Pollutant load removed**: 5,400 lbs/year TSS, 6.8 lbs/year TP, 29 lbs/year TN
D7. **Method of determination and calculations**: Simple Method (calculations in Attachment 2)
D8. **Signed statement**: Included as Attachment 8

E. Public Involvement and Coordination

The secondary project goal of this project was to increase public awareness of the benefits of green infrastructure. The locations for the stormwater BMPs were chosen to enhance public education. Here are some of the things that Framingham did to increase public awareness:

- The green infrastructure, including the support from MassDEP, was a highlight of the grand opening of the skatepark on June 21, 2018. The grand opening was widely advertised by the City on social media and the City's website. Hundreds of residents and skateboarding enthusiasts attended. The Mayor and MassDEP's Deputy Regional Director gave speeches. Access Framingham, the local cable access channel, covered the event. Translation services were provided. Building off the excitement and momentum already generated by the new skatepark really helped increase the awareness of the green infrastructure and benefits of integrating green infrastructure into City projects.
- The DPW reached out to the New England Wildlife Society (NEWS), based at the Garden in the Woods in Framingham, MA. The City purchased native plants from the NEWS for the raingarden and bioretention areas. The City hopes to partner with NEWS and the Ecological Landscape Alliance to teach more residents about the benefits of rain gardens and use our facilities for tours and examples.
- An educational sign was designed (based on an example from Garden in the Woods) and placed at Farm Pond Park during the grand opening (**Appendix 7**). The sign is currently a portable poster. The City intends to translate the sign into multiple languages (Portuguese and Spanish) before permanently installing a sign at the park.
- The City has partnered with Mass Audubon for a series of workshops as part of their Shaping Your Future: Greening Your Community program. The first workshop "Put a LID on it: Managing Your Community's Stormwater in a Changing Climate" was held on March 11, 2019 in Framingham. The second workshop, "A walking tour of Framingham's spaces that manage stormwater with nature", which included a site visit to the skatepark, was held on May 8, 2019. One more workshop is planned.

- The DPW held a neighborhood meeting on March 8, 2017 about the construction projects in the neighborhood.
- The DPW coordinated with the Keefe Technical High School's landscape architecture department. The DPW was able to talk to the program educators about the importance of green infrastructures and how the BMPs will improve the water quality at Farm Pond. Then Keefe Tech landscaping students came to the DPW Operations Center to learn more about what we do. The DPW sponsored the annual Arbor Day celebration on May 3, 2019, which brings together the Keefe Tech landscaping students, Public Works staff, Parks and Recreation staff, as well as local tree and landscaping companies. The City continues to engage regularly with the students and staff at Keefe Regional Technical School to provide learning opportunities.

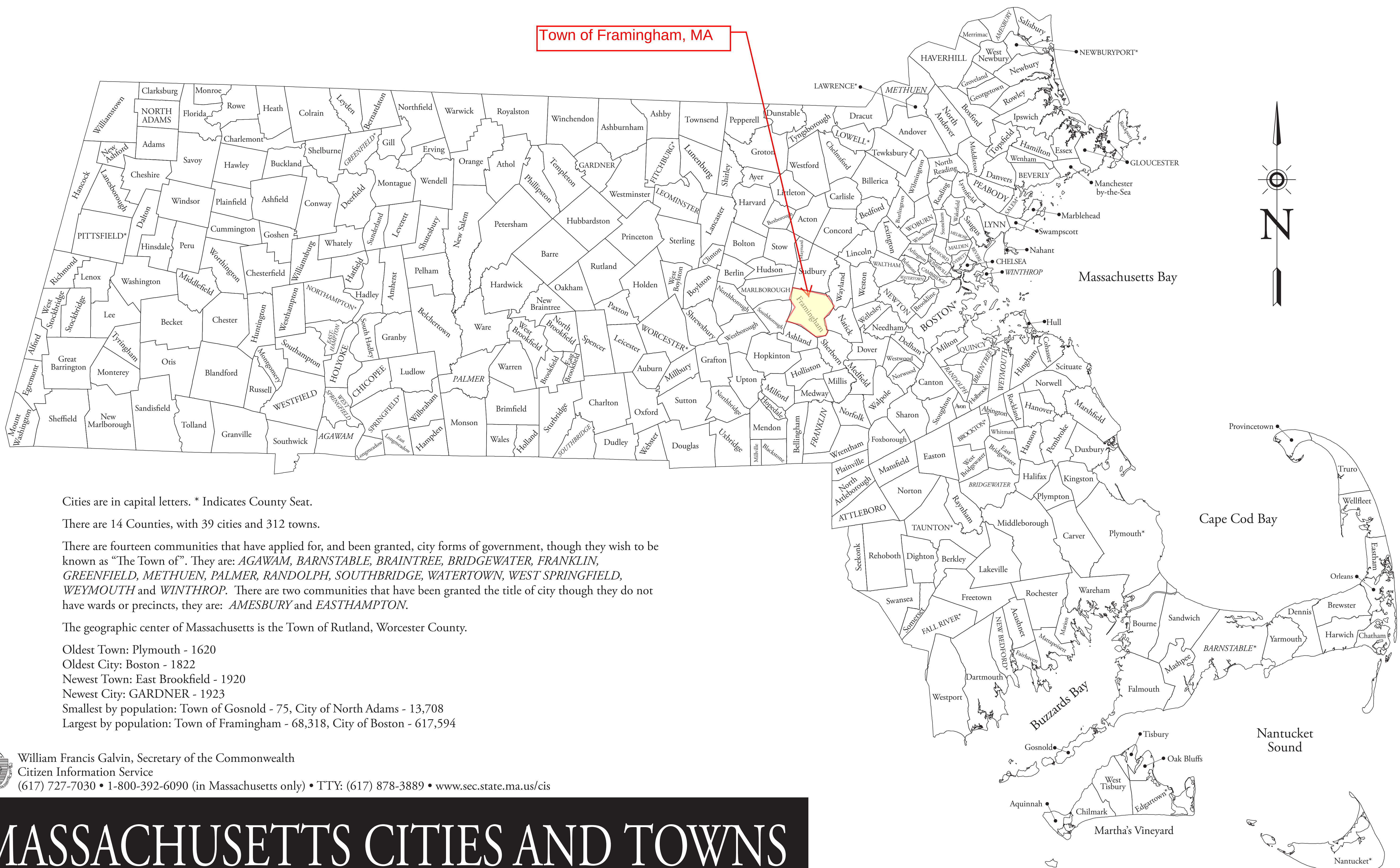
F. Lessons Learned

Implementing green infrastructure in the City has been challenging. Although City bylaws, construction standards, and permit processes allow green infrastructure, developers and City departments tend to prefer traditional "tried & true" gray infrastructure. Some of the lessons learned from this project include:

- Integrating stormwater quality improvements into already planned capital projects has its advantages and disadvantages. Integrating projects is cost beneficial. Synchronizing schedules was challenging.
    - Our initial intent was to incorporate green infrastructure at Keefe Technical High School with the nearby bridge project and roadway project. When those projects became more complicated and were delayed, the school became less inclined to allow the green infrastructure construction because they were concerned about the disruptiveness of continued construction near their front entrance. Eventually, the City revised the project design to limit disruption to the school.
- Maintenance for public green infrastructure projects is challenging.
    - We used native plants and planted in the spring. The weeds took over more quickly than we anticipated. Planting in the fall would help mitigate against the weeds and provide native species more time to germinate over the fall and winter to have a better chance of survival.
    - Green infrastructure is different from typical landscaped areas or lawn areas, which municipal staff feel comfortable maintaining. Even with an operations & maintenance manual, municipal staff were worried about weeding the green infrastructure in fear of removing a plant that was supposed to be there. A lesson learned was to involve the municipal landscaping crew in the design process and design municipal green infrastructure to their comfort level to improve long-term maintenance. A gently sloped, grassed bioretention swale would have been as effective, aesthetically pleasing, and easier to maintain with equipment the City already owns than a bioretention swale with a variety of plantings.
- Incorporating green infrastructure into a project that already have a lot of community support (e.g. skate park) increased public awareness. Hundreds of people attended the skate park's grand opening and have used it since opening. Also, public outreach was more successful since multiple media platforms (e.g. local newspapers, cable access, and social media) covered the event.
- Parks & Recreation and Public Works are great partners for green infrastructure projects. The Parks & Recreation provided the space, proximity to the receiving waterbody, and public engagement. The Public Works provided the planning, technical support, and construction management. Using the strengths of both departments improved the overall project for the City.
- Volunteers from BOSE Corporation (a local business) assisted with the plantings. Not only did this save money, it also increased awareness and created more community ownership of the project. Using volunteers is a great way to improve a project.
- The City was able to use in-house staff for design and outreach and an on-call contractor for construction. This saved money, time, and improved overall project management.

Figures

Figure 1 - LOCUS



Cities are in capital letters. * Indicates County Seat.

There are 14 Counties, with 39 cities and 312 towns.

There are fourteen communities that have applied for, and been granted, city forms of government, though they wish to be known as "The Town of". They are: *AGAWAM, BARNSTABLE, BRAINTREE, BRIDGEWATER, FRANKLIN, GREENFIELD, METHUEN, PALMER, RANDOLPH, SOUTHBRIDGE, WATERTOWN, WEST SPRINGFIELD, WEYMOUTH* and *WINTHROP*. There are two communities that have been granted the title of city though they do not have wards or precincts, they are: *AMESBURY* and *EASTHAMPTON*.

The geographic center of Massachusetts is the Town of Rutland, Worcester County.

Oldest Town: Plymouth - 1620
Oldest City: Boston - 1822
Newest Town: East Brookfield - 1920
Newest City: GARDNER - 1923
Smallest by population: Town of Gosnold - 75, City of North Adams - 13,708
Largest by population: Town of Framingham - 68,318, City of Boston - 617,594

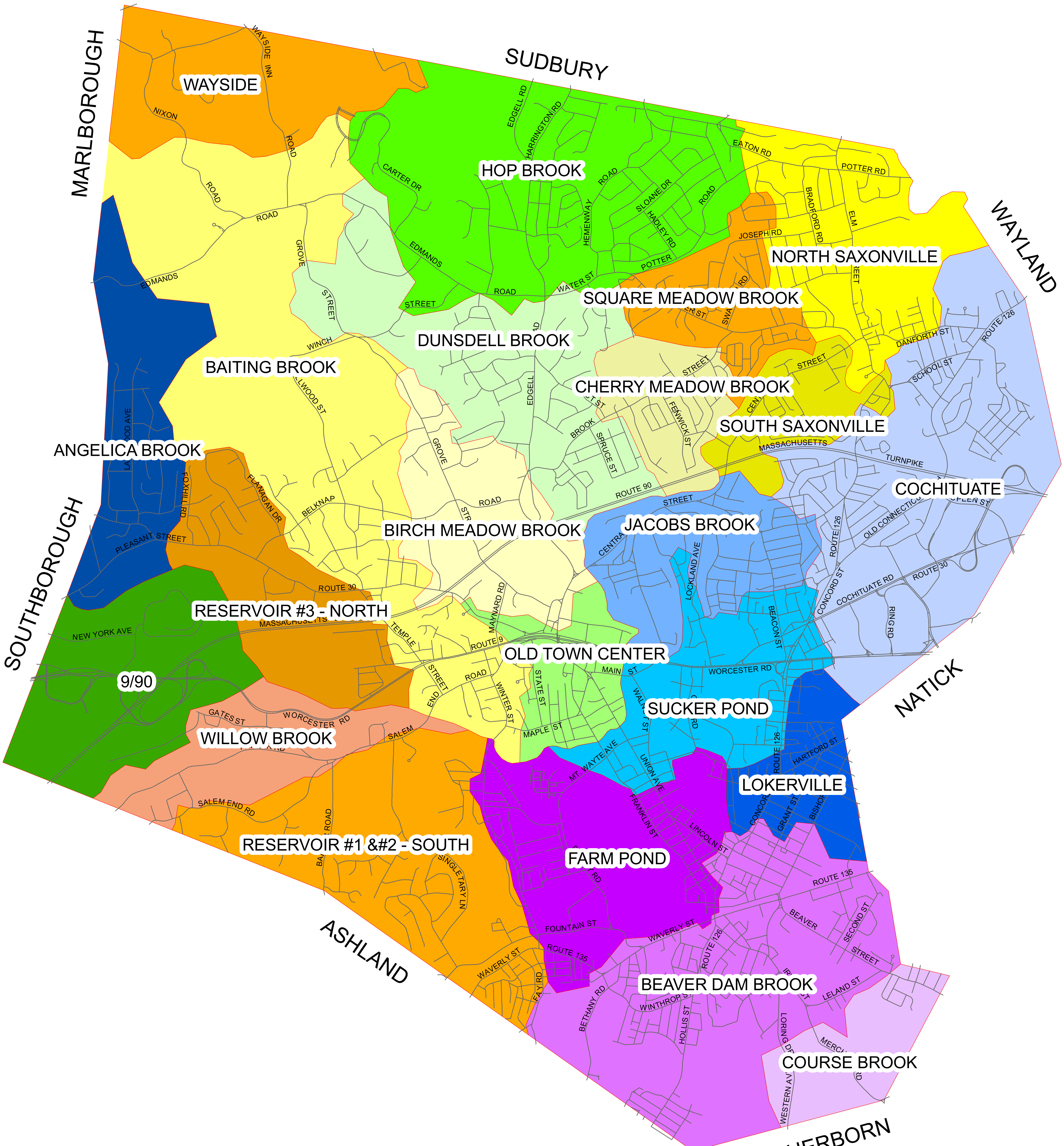
William Francis Galvin, Secretary of the Commonwealth
Citizen Information Service
(617) 727-7030 • 1-800-392-6090 (in Massachusetts only) • TTY: (617) 878-3889 • www.sec.state.ma.us/cis

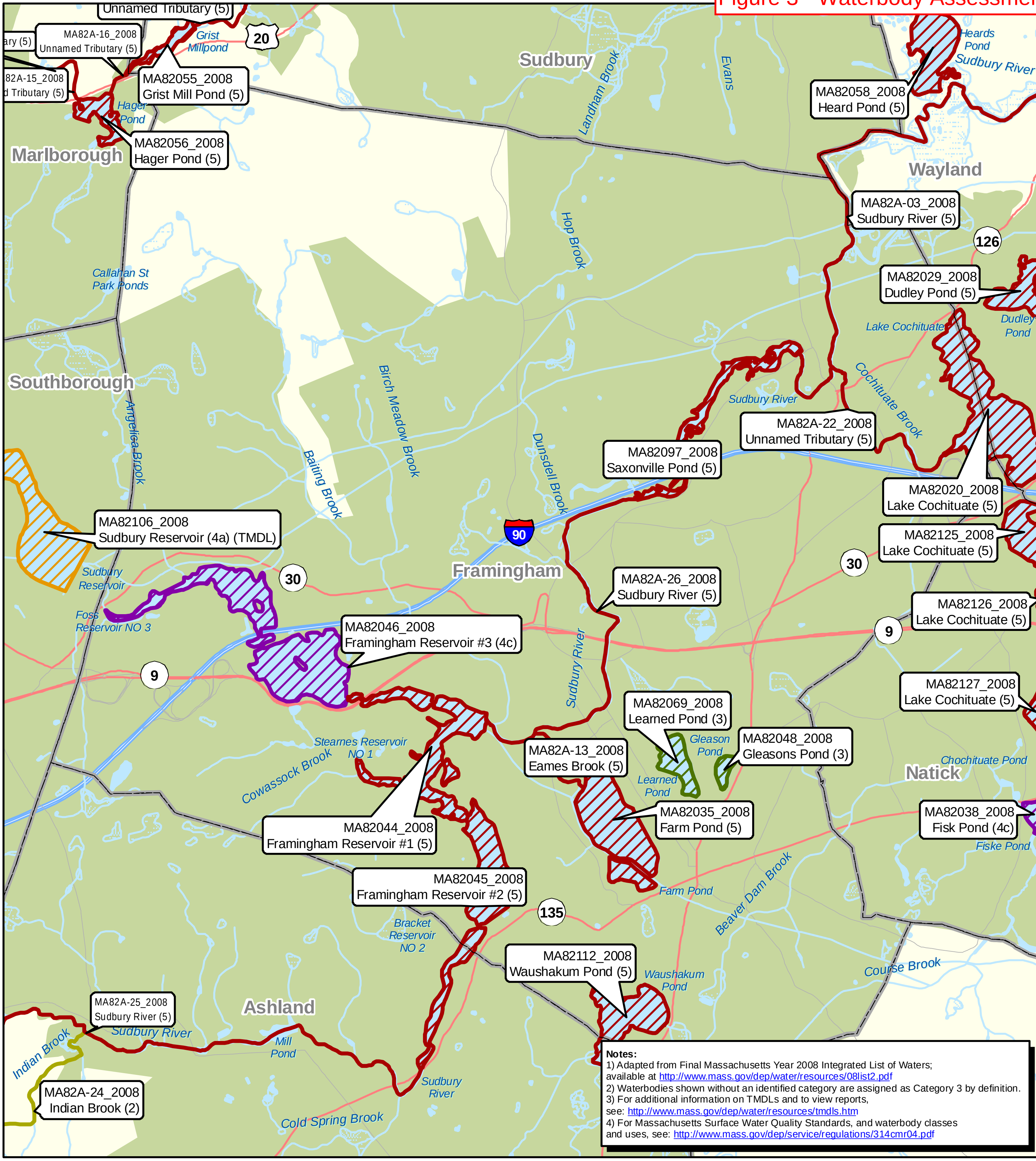
MASSACHUSETTS CITIES AND TOWNS

Updated 11/21/11 (population figures are based on the 2010 Census)

Figure 2 - Framingham Sub-basins

Town of Framingham
Sub Basins





Waterbody Assessment and TMDL Status Framingham, MA

EPA

Map produced by EPA Region I GIS Center
Map Tracker ID 6678, February 25, 2010
Data Sources: TeleAtlas, Census Bureau, USGS, MassDEP

Waterbody Label

State ID,
Waterbody Name (Category)
(TMDL(s) approved for this waterbody)

See companion table for a listing of pollutants, non-pollutants, and TMDLs for each waterbody

Assessment of Waterbody Segment

- Category 2: Attaining some uses; other uses not assessed
- Category 3: Insufficient information to make assessments for any use.
- Category 4a: TMDL is completed and approved for one or more pollutants
- Category 4c: Impairment not caused by a pollutant.
- Category 5: Impaired or threatened for one or more uses and requiring a TMDL.

- Waterbodies
- Swamp/Marsh
- MS4 Urbanized Areas (2000 Census)
- Municipal Boundaries

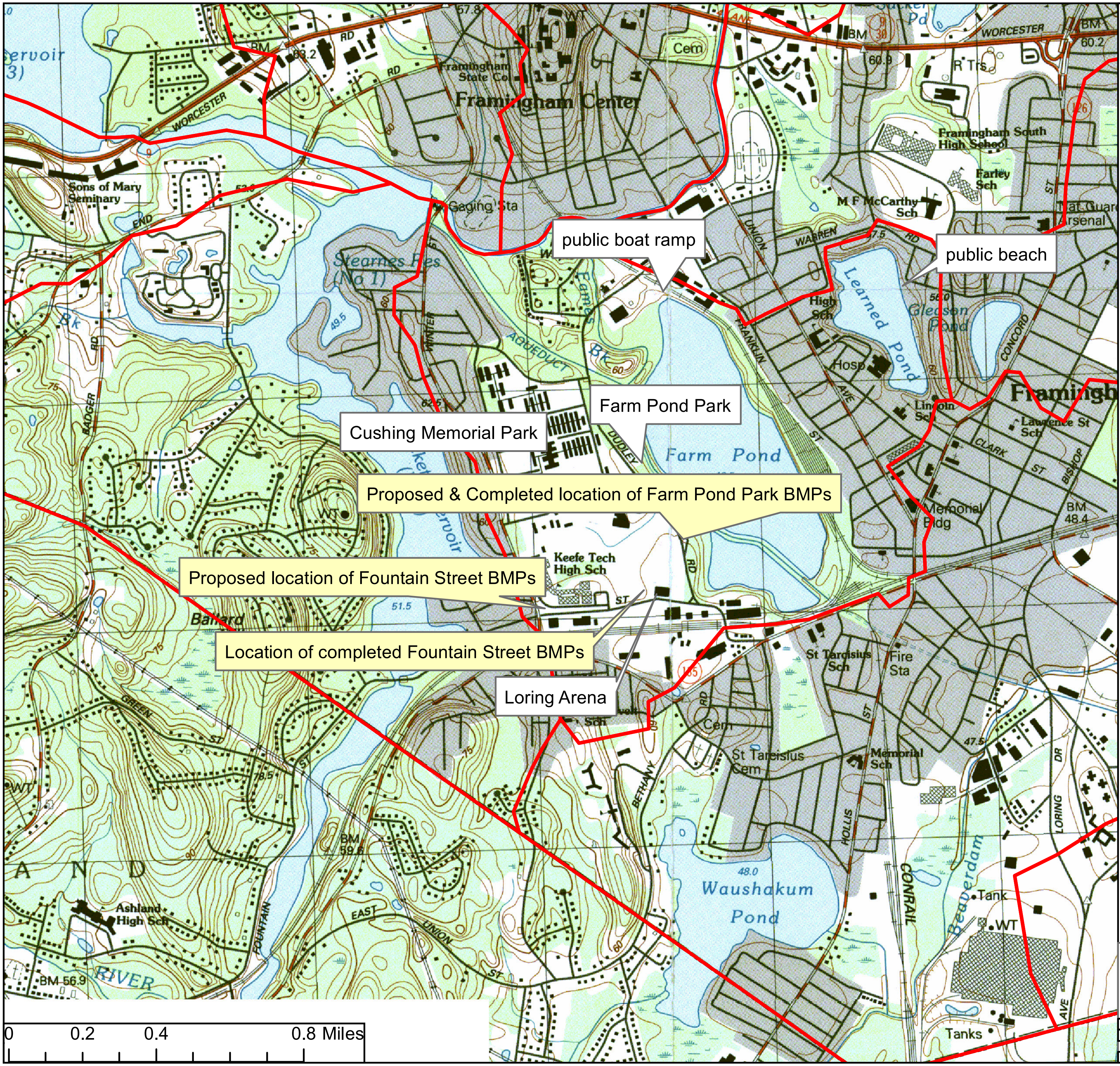


Figure 4

Project Location - Topographic

319 NONPOINT SOURCE
POLLUTION GRANT PROGRAM
Farm Pond Green Infrastructure
City of Framingham

Note: All measurements are approximate.

CITY OF FRAMINGHAM
DEPARTMENT OF PUBLIC WORKS
ENGINEERING AND TRANSPORTATION DIVISION
GEOGRAPHIC INFORMATION SYSTEMS MAP

Executive Director | DPW:	Peter A. Sellers
Director | Engineering Division:	William R. Sedewitz
Production Date:	April 2019

Figure 5

Project Location - 2017 Aerial Photograph

319 NONPOINT SOURCE
POLLUTION GRANT PROGRAM
Farm Pond Green Infrastructure
City of Framingham

Note: All measurements are approximate.

CITY OF FRAMINGHAM
DEPARTMENT OF PUBLIC WORKS
ENGINEERING AND TRANSPORTATION DIVISION
GEOGRAPHIC INFORMATION SYSTEMS MAP

Executive Director | DPW:	Peter A. Sellers
Director | Engineering Division:	William R. Sedewitz
Production Date:	April 2019

Figure 6

Fountain Street BMPs Conceptual Design

319 NONPOINT SOURCE
POLLUTION GRANT PROGRAM
Farm Pond Green Infrastructure
City of Framingham

Note: All measurements are approximate.

CITY OF FRAMINGHAM
DEPARTMENT OF PUBLIC WORKS
ENGINEERING AND TRANSPORTATION DIVISION
GEOGRAPHIC INFORMATION SYSTEMS MAP

Executive Director | DPW:	Peter A. Sellers
Director | Engineering Division:	William R. Sedewitz
Production Date:	June 2019

Figure 7

Fountain Street Completed BMPs

319 NONPOINT SOURCE POLLUTION GRANT PROGRAM
Farm Pond Green Infrastructure
City of Framingham

Note: All measurements are approximate.

CITY OF FRAMINGHAM
DEPARTMENT OF PUBLIC WORKS
ENGINEERING AND TRANSPORTATION DIVISION
GEOGRAPHIC INFORMATION SYSTEMS MAP

Executive Director | DPW:	Peter A. Sellers
Director | Engineering Division:	William R. Sedewitz
Production Date:	June 2019

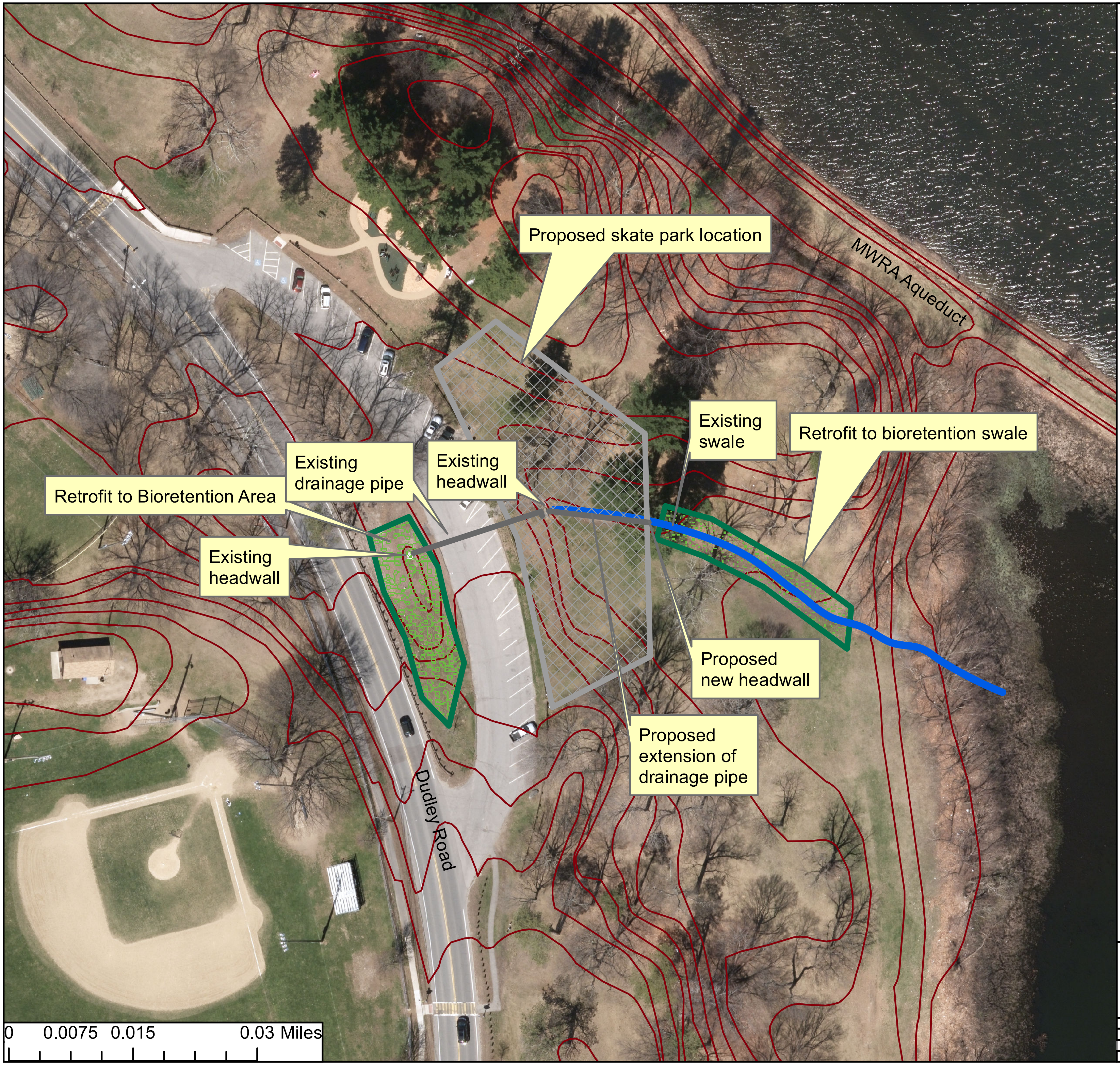


Figure 8

Farm Pond Park Conceptual BMPs

319 NONPOINT SOURCE
POLLUTION GRANT PROGRAM
Farm Pond Green Infrastructure
Town of Framingham

N
W E
S

Note: All measurements are approximate.

TOWN OF FRAMINGHAM
DEPARTMENT OF PUBLIC WORKS
ENGINEERING AND TRANSPORTATION DIVISION
GEOGRAPHIC INFORMATION SYSTEMS MAP

Executive Director | DPW:	Peter A. Sellers
Director | Engineering Division:	William R. Sedewitz
Production Date:	April 2016

Figure 9

Farm Pond Park Completed BMPs

319 NONPOINT SOURCE
POLLUTION GRANT PROGRAM
Farm Pond Green Infrastructure
City of Framingham

Note: All measurements are approximate.

CITY OF FRAMINGHAM
DEPARTMENT OF PUBLIC WORKS
ENGINEERING AND TRANSPORTATION DIVISION
GEOGRAPHIC INFORMATION SYSTEMS MAP

Executive Director | DPW:	Peter A. Sellers
Director | Engineering Division:	William R. Sedewitz
Production Date:	April 2019

Attachment 1 – Project Budget

Project Proposed Budget

Expense Items	s.319 Amount	Non-Federal Match and Source	Total Amount
Salary - By Title and salary range *DPW Executive Director $65-70/hr* *Chief Engineer $55-60/hr* *City Engineer $50-55/hr* *Highway Director $50-55/hr* *Transportation Director $50-55/hr* *Project Manager $45-50/hr* *Stormwater Engineer $45-50/hr* *Stormwater Supervisor $35-40/hr* *Public Relations PM $30-35/hr* *GIS $40-45/hr* *Procurement Administrator $30-35/hr* *DPW Laborers $25-30/hr* *Parks & Recreation Director $45-50/hr* *P&R Facility Manager $35-40/hr* *P&R Operations Manager $40-45/hr* *P&R Facility Manager $35-40/hr* *Keefe Tech HS Director $50-55/hr* *Keefe Facility Manager $25-30/hr* *Keefe Tech Landscape Teacher $25-30/hr*	$0	$39,400	$39,400
Subcontractual Services *BMP Design* *BMP Construction* *Operations and Maintenance Plan* *Easement* **Subcontractual Subtotal**	 $185,000	 $45,285 $29,215 $3,000 $8,000 **$85,500**	 $45,285 $214,215 $3,000 $8,000 **$270,500**
Materials and Supplies (including printing, mailing - should include cost for printing copies and CDs of the final project report, with photographs)	$0	$100	$100
Travel (for auto mileage only @ $.40 /mile)	$0	$0	$0
Totals: Percent	$185,000 60%	$125,000 40%	$310,000 100%

Completed Project Budget

Expense Items	s.319 Amount	Non-Federal Match and Source	Total Amount
Salary - By Title and salary range *DPW Executive Director $65-70/hr* *Chief Engineer $55-60/hr* *City Engineer $50-55/hr* *Highway Director $50-55/hr* *Transportation Director $50-55/hr* *Project Manager $45-50/hr* *Stormwater Engineer $45-50/hr* *Stormwater Supervisor $35-40/hr* *Public Relations PM $30-35/hr* *GIS $40-45/hr* *Procurement Administrator $30-35/hr* *DPW Laborers $25-30/hr* *Parks & Recreation Director $45-50/hr* *P&R Facility Manager $35-40/hr* *P&R Operations Manager $40-45/hr* *P&R Facility Manager $35-40/hr* *Keefe Tech HS Director $50-55/hr* *Keefe Facility Manager $25-30/hr* *Keefe Tech Landscape Teacher $25-30/hr*	$0	$18,533	$18,533
Subcontractual Services *BMP Design* *BMP Construction* *Operations and Maintenance Plan* *Easement* **Subcontractual Subtotal**	 $185,000	 $44,541 $160,440 $3,000 $0 **$207,981**	 $44,541 $345,440 $3,000 $0 **$392,981**
Materials and Supplies (including printing, mailing - should include cost for printing copies and CDs of the final project report, with photographs)	$0	$176	$176
Travel (for auto mileage only @ $.40 /mile)	$0	$0	$0
Totals: Percent	$185,000 45%	$226,690 55%	$411,690 100%

Attachment 2 – Pollutant Removal Calculations

Calculations for Pollutant Loading and Removal for Farm Pond Green Infrastructure BMPs

The City used the Simple Method to calculate urban stormwater loads.[1]

Estimated Pollutant Removal (lb/year)

BMP	TSS	Phosphorus	Nitrogen
Fountain Street BMPs	5,400	6.8	29
Farm Pond Park BMPs	1,325	2.5	11
TOTAL	**6,725**	**9.3**	**40**

Fountain Street BMPs

Annual Runoff - Fountain Street BMPs

The Simple Method calculates annual runoff as a product of annual runoff volume and a runoff coefficient (Rv).

Runoff volume is calculated as:

$$\mathbf{R = P * Pj * Rv}$$

Where: R = Annual runoff (inches)
P = Annual rainfall (inches)
Pj = Fraction of annual rainfall events that produce runoff (usually 0.9)
Rv = Runoff coefficient

$$\mathbf{Rv=0.05+0.9Ia}$$

Where: Ia = Impervious fraction

The City's GIS was used to delineate the drainage area for the BMPs. City GIS was also used to calculate the drainage area and impervious area. The areas are larger than the proposed areas in the grant application because the BMP was redesigned.

Area (A) = 5.9 acres
Impervious Area (Ia) = 5.1 acres (86%)

Therefore,
Rv = 0.05+0.9(.86)
Rv = 0.824

The City obtained precipitation data from the Massachusetts Department of Conservation and Recreation's Office of Water Resources. Data from station SUD518 in Sudbury was used because it is within the same Sudbury watershed as the project site and was the closest station to the project site. Using the data from DCR, the City compiled the annual totals in inches. Only full 12-month data sets

[1] Schueler, T. Controlling urban runoff: a practical manual for planning and designing urban BMPs. Metropolitan Washington Council of Governments, 1987.

were used. The City averaged the annual totals from 2002 to 2013 to obtain the annual rainfall in inches. P = 51.36 inches. This is consistent with the state's recently published 2018 Massachusetts State Hazard Mitigation and Climate Adaptation Plan which reported annual rainfall for Massachusetts at 47 inches (1971-2001 data) with projected increases by the end of the century at 54.3 inches.[2]

Therefore,
R = P * Pj * Rv
R= 51.36 inches * 0.9 * 0.824
R = 38.1 inches

Pollutant Loads - Fountain Street BMPs

The Simple Method estimates pollutant loads for chemical constituents as a product of annual runoff volume and pollutant concentration, as:

L = 0.226 * R * C * A

Where: L = Annual load (lbs)
R = Annual runoff (inches)
C = Pollutant concentration (mg/l)
A = Area (acres)
0.226 = Unit conversion factor

The City obtained pollutant concentration data from the New Hampshire Stormwater Manual.[3] The City used the following pollutant loads:

	TSS (mg/L)	TP (mg/L)	TN (mg/L)
Residential	100	0.4	2.2
Residential street	172	0.55	1.4

TSS Pollutant Load - Fountain Street BMPs

The City developed a weighted pollutant concentration using the TSS pollutant concentration value of 100 mg/L for "residential" was used for school and City buildings and grounds (3.8 acres). The TSS pollutant concentration value of 172 mg/L for "residential street" was used for Fountain Street (2.1 acres).

$$C = \frac{(100 \text{ mg/L} * 3.8 \text{ acres}) + (172 \text{ mg/L} * 2.1 \text{ acres})}{5.9 \text{ acres}} = 125.6 \text{ mg/L}$$

Therefore,
L = 0.226 * R * C * A

[2] Massachusetts State Hazard Mitigation and Climate Adaptation Plan, Executive Office of Energy and Environmental Affairs and the Massachusetts Emergency Management Agency, September 2018.
[3] New Hampshire Stormwater Manual, Volume 1, Stormwater and Antidegradation, USEPA, New Hampshire Department of Environmental Serices, and Comprehensive Environmental Inc., December 2008. https://www.des.nh.gov/organization/commissioner/pip/publications/wd/documents/wd-08-20a.pdf

L = 0.226 * 38.1 inches * 125.6 mg/L * 5.9 acres
L = 6,380 lbs/year

TSS Pollutant Load Reduction - Fountain Street BMPs

According to the Massachusetts Department of Environmental Protection's Stormwater Handbook[4], proprietary separators can be used. The Stormceptor's manufacturers guidance[5] states that the units can remove 85% TSS.

Therefore,
Pollutant Removal = 0.85 * L
Pollutant Removal = 0.85 * 6,380 lbs/year

TSS Pollutant Removal = 5,423 lbs/year ~ 5,400 lbs/year

Total Phosphorus Pollutant Load - Fountain Street BMPs

The City developed a weighted pollutant concentration using the TP pollutant concentration value of 0.4 mg/L for "residential" was used for school and City buildings and grounds (3.8 acres). The TP pollutant concentration value of 0.55 mg/L for "residential street" was used for Fountain Street (2.1 acres).

$$C = \frac{(0.4 \text{ mg/L} * 3.8 \text{ acres}) + (0.55 \text{ mg/L} * 2.1 \text{ acres})}{5.9 \text{ acres}} = 0.45 \text{ mg/L}$$

Therefore,
L = 0.226 * R * C * A
L = 0.226 * 38.1 inches * 0.45 mg/L * 5.9 acres
L = 22.8 lbs/year

Total Phosphorus Pollutant Load Reduction - Fountain Street BMPs

According to the Massachusetts Department of Environmental Protection's Stormwater Handbook, proprietary separators can be used. The Stormceptor's manufacturers guidance states that the units can remove 30% total phosphorus.

Therefore,
Pollutant Removal = 0.3 * L
Pollutant Removal = 0.3 * 22.8 lbs/year

Phosphorus Pollutant Removal = 6.84 lbs/year ~ 6.8 lbs/year

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[4] Massachusetts Stormwater Handbook, Volume 1: Overview of Massachusetts Stormwater Standards, Massachusetts Department of Environmental Protection, 1997, updated 2008, https://www.mass.gov/guides/massachusetts-stormwater-handbook-and-stormwater-standards#stormwater-handbook-volume-1

[5] Stormwater Proprietary Technology Report, Stormceptor® Stormwater Treatment System, Rinker Materials, prepared for Rhode Island Department of Environmental Management, January 7, 2016. http://www.dem.ri.gov/programs/benviron/water/permits/swcoord/pdf/stormceptorpub.pdf

Total Nitrogen Pollutant Load - Fountain Street BMPs

The City developed a weighted pollutant concentration using the TN pollutant concentration value of 2.2 mg/L for "residential" was used for school and City buildings and grounds (3.8 acres). The TN pollutant concentration value of 1.4 mg/L for "residential street" was used for Fountain Street (2.1 acres).

$$C = \frac{(2.2 \text{ mg/L} * 3.8 \text{ acres}) + (1.4 \text{ mg/L} * 2.1 \text{ acres})}{5.9 \text{ acres}} = 1.9 \text{ mg/L}$$

Therefore,
L = 0.226 * R * C * A
L = 0.226 * 38.1 inches * 1.9 mg/L * 5.9 acres
L = <u>96.5 lbs/year</u>

Total Nitrogen Pollutant Load Reduction - Fountain Street BMPs

The Stormceptor's manufacturer's guidance states that the units can remove 30% total nitrogen.

Therefore,
Pollutant Removal = 0.3 * L
Pollutant Removal = 0.3 * 96.5 lbs/year

<u>Nitrogen Pollutant Removal = 28.95 lbs/year</u> ~ 29 lbs/year

Farm Pond Park BMPs

Annual Runoff – Farm Pond BMPs

Runoff volume is calculated as:

$$\mathbf{R = P * Pj * Rv}$$

Where: R = Annual runoff (inches)
P = Annual rainfall (inches)
Pj = Fraction of annual rainfall events that produce runoff (usually 0.9)
Rv = Runoff coefficient

$$\mathbf{Rv=0.05+0.9Ia}$$

Where: Ia = Impervious fraction

The City's GIS was used to delineate the drainage area for the BMPs. City GIS was also used to calculate the drainage area and impervious area. The actual drainage area is the same as the conceptual design drainage area, but the impervious area increased by 0.4 acres as a result of the installation of the skatepark and multi-use path.

Area (A) = 3.6 acres
Impervious Area (Ia) = 1.5 acres (42%)

Therefore,
Rv = 0.05+0.9(.42)
Rv = <u>0.428</u>

The City obtained precipitation data from the Massachusetts Department of Conservation and Recreation's Office of Water Resources. Data from station SUD518 in Sudbury was used because it is within the same Sudbury watershed as the project site and was the closest station to the project site. Using the data from DCR, the City compiled the annual totals in inches. Only full 12-month data sets were used. The City averaged the annual totals from 2002 to 2013 to obtain the annual rainfall in inches. P = 51.36 inches. This is consistent with the state's recently published 2018 Massachusetts State Hazard Mitigation and Climate Adaptation Plan which reported annual rainfall for Massachusetts at 47 inches (1971-2001 data) with projected increases by the end of the century at 54.3 inches.[6]

Therefore,
R = P * Pj * Rv
R= 51.36 inches * 0.9 * 0.428
R = <u>19.8 inches</u>

[6] Massachusetts State Hazard Mitigation and Climate Adaptation Plan, Executive Office of Energy and Environmental Affairs and the Massachusetts Emergency Management Agency, September 2018.

Pollutant Loads – Farm Pond BMPs

The Simple Method estimates pollutant loads for chemical constituents as a product of annual runoff volume and pollutant concentration, as:

$$L = 0.226 * R * C * A$$

Where: L = Annual load (lbs)
R = Annual runoff (inches)
C = Pollutant concentration (mg/l)
A = Area (acres)
0.226 = Unit conversion factor

The City obtained pollutant concentration data from the New Hampshire Stormwater Manual.[7] The City used the following pollutant loads:

	TSS (mg/L)	TP (mg/L)	TN (mg/L)
Residential	100	0.4	2.2
Residential street	172	0.55	1.4
Urban open	51	0.11	1.74

TSS Pollutant Load – Farm Pond BMPs

The City developed a weighted pollutant concentration using the TSS pollutant concentration value of 51 mg/L for "urban open" for park area including grassed areas, other vegetated areas, and the playground (2.1 acres). The TSS pollutant concentration value of 150 mg/L for "residential street" was used for Dudley Road and the parking area (1 acre). The TSS pollutant concentration value of 100 mg/L for "residential" was used for the new skatepark and path (0.5 acre) which is impervious but not expected to create as much of a pollutant load as typical roads.

$$C = \frac{(51\text{ mg/L} * 2.1\text{ acres}) + (172\text{ mg/L} * 1\text{ acre}) + (100\text{ mg/L} * 0.5\text{ acre})}{3.6\text{ acres}} = 91.4\text{ mg/L}$$

Therefore,
L = 0.226 * R * C * A
L = 0.226 * 19.8 inches * 91.4 mg/L * 3.6 acres
L = <u>1,472 lbs/year</u>

TSS Pollutant Load Reduction – Farm Pond BMPs

According to the Massachusetts Department of Environmental Protection's Stormwater Handbook, bioretention areas including rain gardens provide 90% removal of total suspended solids.

Therefore,

[7] New Hampshire Stormwater Manual, Volume 1, Stormwater and Antidegradation, USEPA, New Hampshire Department of Environmental Serices, and Comprehensive Environmental Inc., December 2008. https://www.des.nh.gov/organization/commissioner/pip/publications/wd/documents/wd-08-20a.pdf

Pollutant Removal = 0.9 * L
Pollutant Removal = 0.9 * 1,472 lbs/year

TSS Pollutant Removal = 1,325 lbs/year

Total Phosphorus Pollutant Load – Farm Pond BMPs

The City developed a weighted pollutant concentration using the TP pollutant concentration value of 0.11 mg/L for "urban open" for park area including grassed areas, other vegetated areas, and the playground (2.1 acres). The TP pollutant concentration value of 0.55 mg/L for "residential street" was used for Dudley Road and the parking area (1 acre). The TP pollutant concentration value of 0.4 mg/L for "residential" was used for the new skatepark and path (0.5 acre) which is impervious but not expected to create as much of a pollutant load as typical roads.

$$C = \frac{(0.11\text{ mg/L} * 2.1\text{ acres}) + (0.55\text{ mg/L} * 1\text{ acre}) + (0.4\text{ mg/L} * 0.5\text{ acre})}{3.6\text{ acres}} = 0.27\text{ mg/L}$$

Therefore,
L = 0.226 * R * C * A
L = 0.226 * 19.8 inches * 0.27 mg/L * 3.6 acres
L = 4.3 lbs/year

Total Phosphorus Pollutant Load Reduction – Farm Pond BMPs

According to the Massachusetts Department of Environmental Protection's Stormwater Handbook, bioretention areas including rain gardens provide 30% to 90% removal of total phosphorus. We assumed 60% removal for these calculations.

Therefore,
Pollutant Removal = 0.6 * L
Pollutant Removal = 0.6 * 4.3 lbs/year

Phosphorus Pollutant Removal = 2.5 lbs/year

Total Nitrogen Pollutant Load – Farm Pond BMPs

The City developed a weighted pollutant concentration using the TN pollutant concentration value of 1.74 mg/L for "urban open" for park area including grassed areas, other vegetated areas, and the playground (2.1 acres). The TN pollutant concentration value of 1.4 mg/L for "residential street" was used for Dudley Road and the parking area (1 acre). The TN pollutant concentration value of 2.2 mg/L for "residential" was used for the new skatepark and path (0.5 acre) which is impervious but not expected to create as much of a pollutant load as typical roads.

$$C = \frac{(1.74\text{ mg/L} * 2.1\text{ acres}) + (1.4\text{ mg/L} * 1\text{ acre}) + (2.2\text{ mg/L} * 0.5\text{ acre})}{3.6\text{ acres}} = 1.7\text{ mg/L}$$

Therefore,
L = 0.226 * R * C * A

L = 0.226 * 19.8 inches * 1.7 mg/L * 3.6 acres
L = <u>27.39 lbs/year</u>

Total Nitrogen Pollutant Load Reduction – Farm Pond BMPs

According to the Massachusetts Department of Environmental Protection's Stormwater Handbook, bioretention areas including rain gardens provide 30% to 50% removal of total nitrogen, if soil media is at least 30 inches. We assumed 40% removal for these calculations.

Therefore,
Pollutant Removal = 0.4 * L
Pollutant Removal = 0.4 * 27.39 lbs/year

<u>Nitrogen Pollutant Removal = 10.96 lbs/year</u> ~ 11 lbs/year

Attachment 3 – Photographs

Photograph 1: Skatepark (taken from drone) at Grand Opening June 21, 2018.

Photograph 2: Temporary educational sign in front of bioretention area at Grand Opening June 21, 2018.

Photograph 3: BEFORE (Nov 2017)
Previously existing headwall and swale, looking northwest towards parking area.

Photograph 4: AFTER (May 2018)
Same headwall with retrofitted bioretention swale, looking northwest towards parking area.

Photograph 5: BEFORE (Nov 2017)
Location of (future) skatepark and multi-use path, looking southeast towards Farm Pond from parking area.

Photograph 6: AFTER (June 2018)
Completed skatepark and multi-use path, looking southeast towards Farm Pond from path.

Photograph 7: DURING CONSTRUCTION (May 2018)
Community volunteers installing the plantings.

Photograph 8: DURING CONSTRUCTION (May 2018)
Community volunteers installing the plantings.

Photograph 9: DURING CONSTRUCTION (April 2018)
Grading work for the raingarden. Farm Pond is to the right in this photo.

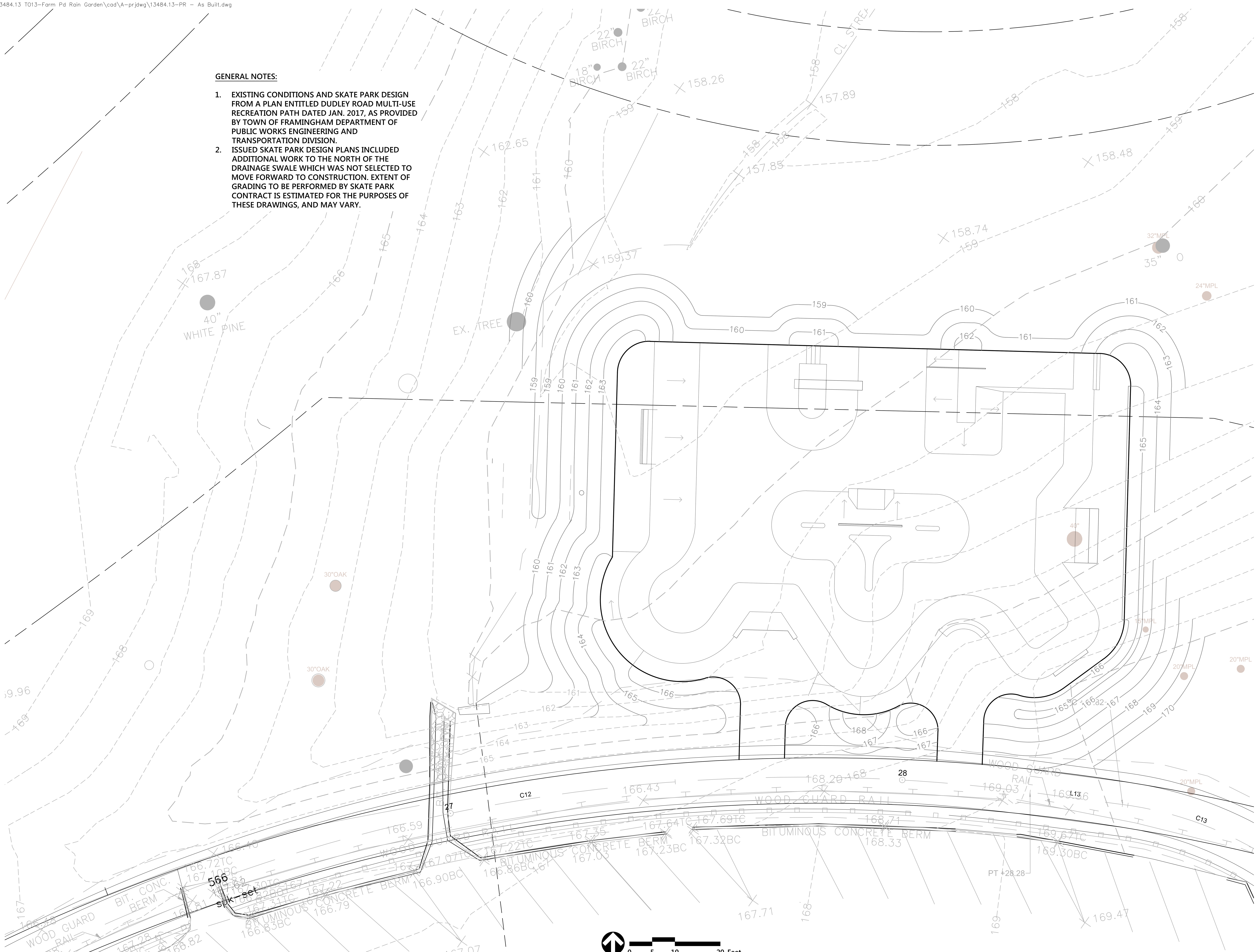
Photograph 10: AFTER (June 2018)
Completed raingarden (on the lower right side of photo). Farm Pond is to the right in this photo.

Attachment 4 – As-built drawings

\\Vhb\proj\Wat-TE\13484.13 T013-Farm Pd Rain Garden\cad\A-prjdwg\13484.13-PR - As Built.dwg

GENERAL NOTES:

1. EXISTING CONDITIONS AND SKATE PARK DESIGN FROM A PLAN ENTITLED DUDLEY ROAD MULTI-USE RECREATION PATH DATED JAN. 2017, AS PROVIDED BY TOWN OF FRAMINGHAM DEPARTMENT OF PUBLIC WORKS ENGINEERING AND TRANSPORTATION DIVISION.
2. ISSUED SKATE PARK DESIGN PLANS INCLUDED ADDITIONAL WORK TO THE NORTH OF THE DRAINAGE SWALE WHICH WAS NOT SELECTED TO MOVE FORWARD TO CONSTRUCTION. EXTENT OF GRADING TO BE PERFORMED BY SKATE PARK CONTRACT IS ESTIMATED FOR THE PURPOSES OF THESE DRAWINGS, AND MAY VARY.



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Farm Pond Skatepark Rain Garden

Framingham, Massachusetts

No.	Revision	Date	Appvd.
-	AS-BUILT DRAWING	06/29/2018	

Designed by | Checked by

Issued for | Date: July 20, 2017

Drawing Title

Existing Conditions Plan

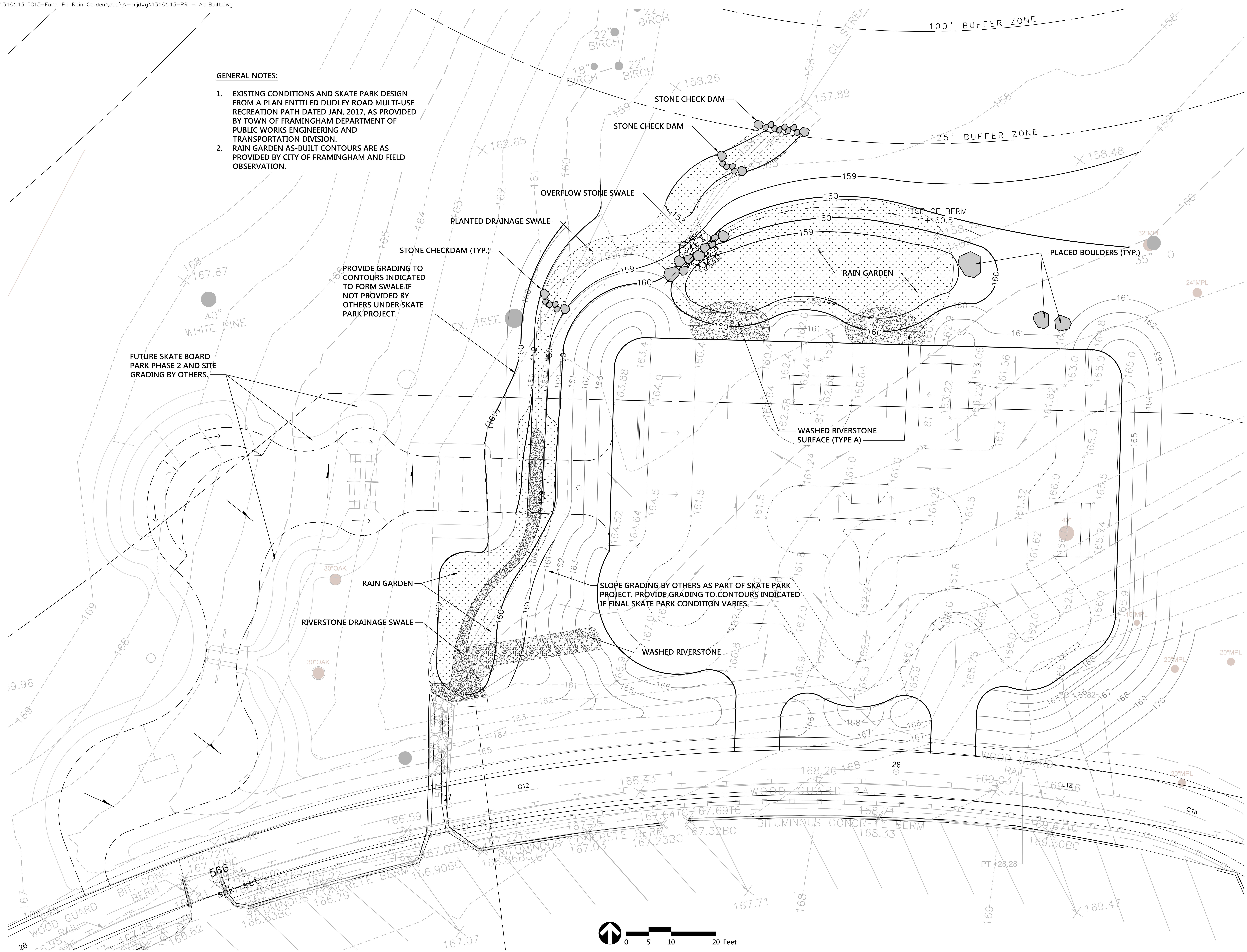
Drawing Number

EX-1

Sheet 1 of 5

Project Number
13484.13

Saved Friday, June 29, 2018 4:17:01 PM KLYNCH Plotted Friday, June 29, 2018 4:17:32 PM Lynch, Kathleen



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LEGEND

- PLACED BOULDERS
- CHECK DAM
- OVERFLOW STONE SWALE
- RIVERSTONE DRAINAGE SWALE
- WASHED RIVERSTONE SURFACE
- SHRUBS / GRASSES / PERENNIALS

Farm Pond Skatepark Rain Garden

Framingham, Massachusetts

No.	Revision	Date	Appvd.
"	AS-BUILT DRAWING	06/29/2018	

Designed by | Checked by

Issued for | Date: July 20, 2017

Drawing Title

Grading and Materials Plan

Drawing Number

L-1

Sheet 2 of 5

Project Number 13484.13

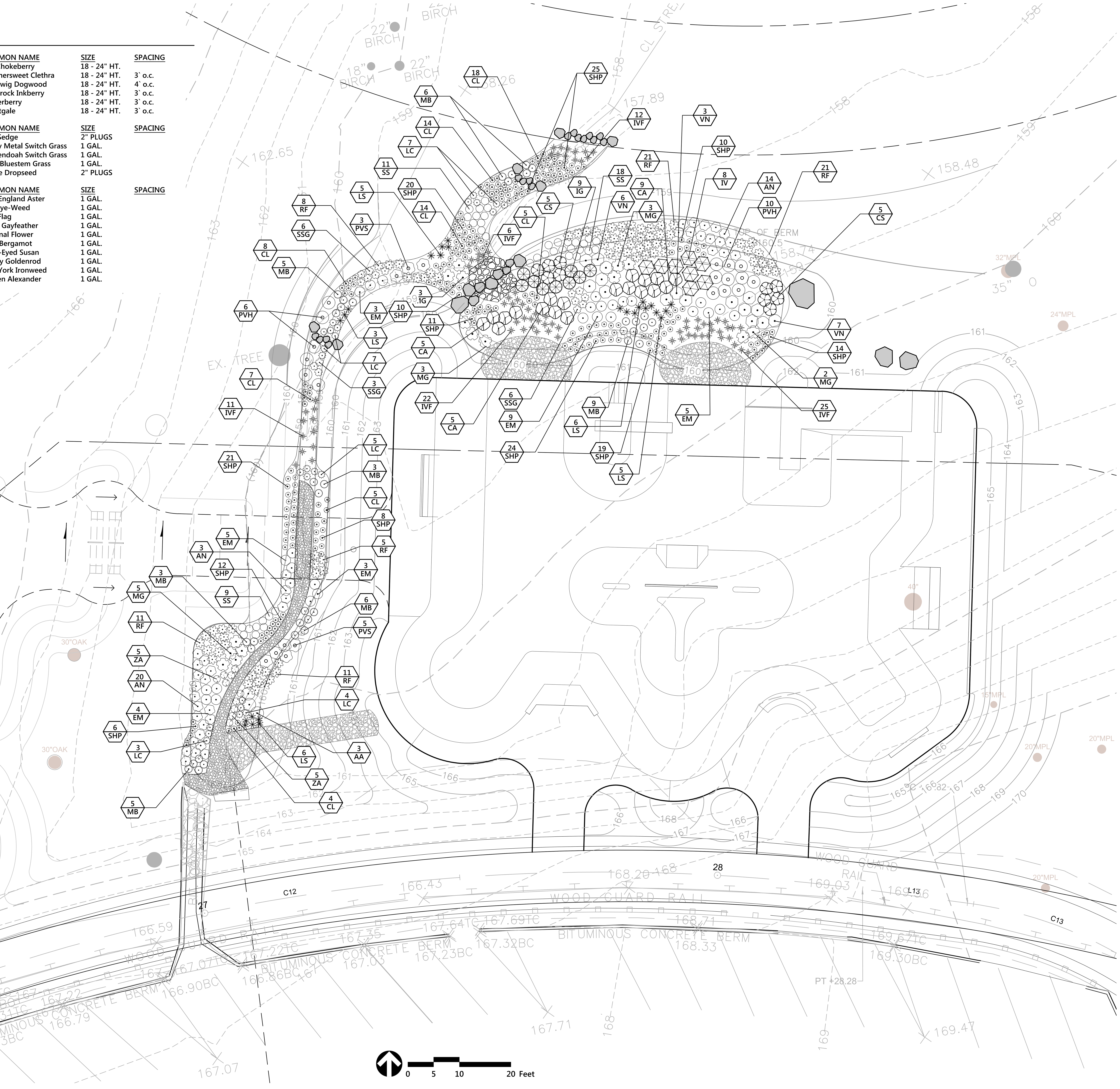
\\Vhb\proj\Wat-TE\13484.13 T013-Farm Pd Rain Garden\cad\A-prjdwg\13484.13-PR - As Built.dwg

PLANT SCHEDULE

SHRUBS	QTY	BOTANICAL NAME	COMMON NAME	SIZE	SPACING
AA	3	Aronia arbutifolia	Red Chokeberry	18 - 24" HT.	
CA	19	Clethra alnifolia	Summersweet Clethra	18 - 24" HT.	3` o.c.
CS	10	Cornus sericea	Red Twig Dogwood	18 - 24" HT.	4` o.c.
IG	9	Ilex glabra `Densa`	Shamrock Inkberry	18 - 24" HT.	3` o.c.
IV	8	Ilex verticillata	Winterberry	18 - 24" HT.	3` o.c.
MG	16	Myrica gale	Sweetgale	18 - 24" HT.	3` o.c.
GRASSES	**QTY**	**BOTANICAL NAME**	**COMMON NAME**	**SIZE**	**SPACING**
CL	75	Carex lupulina	Hop Sedge	2" PLUGS	
PVH	16	Panicum virgatum `Heavy Metal`	Heavy Metal Switch Grass	1 GAL.	
PVS	8	Panicum virgatum `Shenandoah`	Shenendoah Switch Grass	1 GAL.	
SS	38	Schizachyrium scoparium	Little Bluestem Grass	1 GAL.	
SHP	180	Sporobolus heterolepis	Prairie Dropseed	2" PLUGS	
PERENNIALS	**QTY**	**BOTANICAL NAME**	**COMMON NAME**	**SIZE**	**SPACING**
AN	37	Aster novae-angliae	New England Aster	1 GAL.	
EM	29	Eupatorium maculatum	Joe-Pye-Weed	1 GAL.	
IVF	76	Iris versicolor	Blue Flag	1 GAL.	
LS	25	Liatris spicata	Spike Gayfeather	1 GAL.	
LC	26	Lobelia cardinalis	Cardinal Flower	1 GAL.	
MB	37	Monarda fistulosa	Wild Bergamot	1 GAL.	
RF	77	Rudbeckia fulgida	Black-Eyed Susan	1 GAL.	
SSG	15	Solidago speciosa	Showy Goldenrod	1 GAL.	
VN	16	Vernonia noveboracensis	New York Ironweed	1 GAL.	
ZA	10	Zizia aurea	Golden Alexander	1 GAL.	

GENERAL NOTES:

1. RAIN GARDEN AS-BUILT PLANTING LAYOUT IS BASED ON PHOTOGRAPHS OF ORIGINAL INSTALLATION, AND ARE GENERALLY APPROXIMATE ONLY, TO BE USED FOR REFERENCE FOR FUTURE PLANT REPLACEMENTS IF REQUIRED.
2. RAIN GARDEN AS-BUILT CONTOURS ARE AS PROVIDED BY CITY OF FRAMINGHAM AND FIELD OBSERVATION.



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Farm Pond Skatepark Rain Garden

Framingham, Massachusetts

No.	Revision	Date	Appvd.
'	AS-BUILT DRAWING	06/29/2018	

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Drawing Title

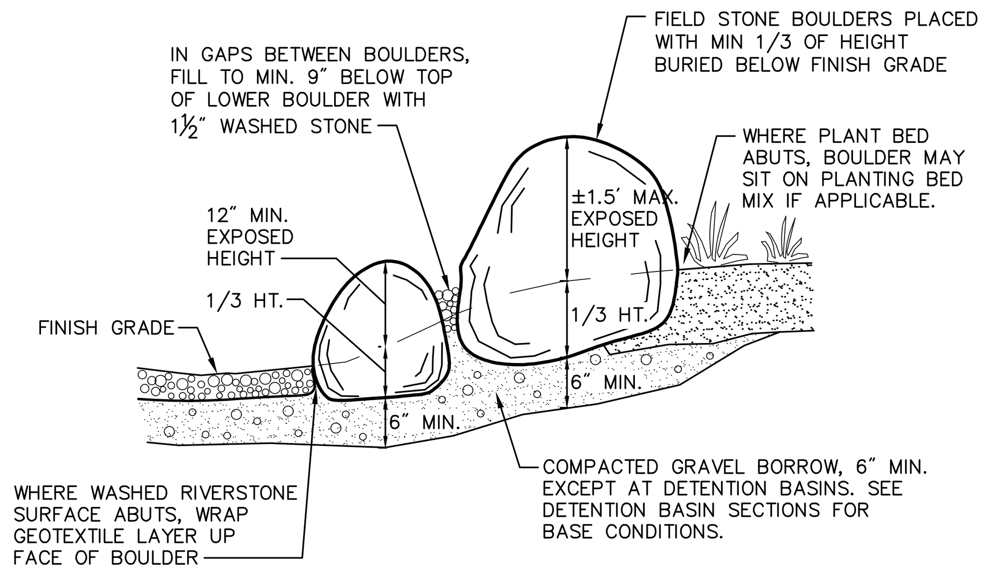
Planting Plan

Drawing Number L-2

Sheet 3 of 5

Project Number 13484.13

Saved Friday, June 29, 2018 4:17:01 PM KLYNCH Plotted Friday, June 29, 2018 4:17:48 PM Lynch, Kathleen

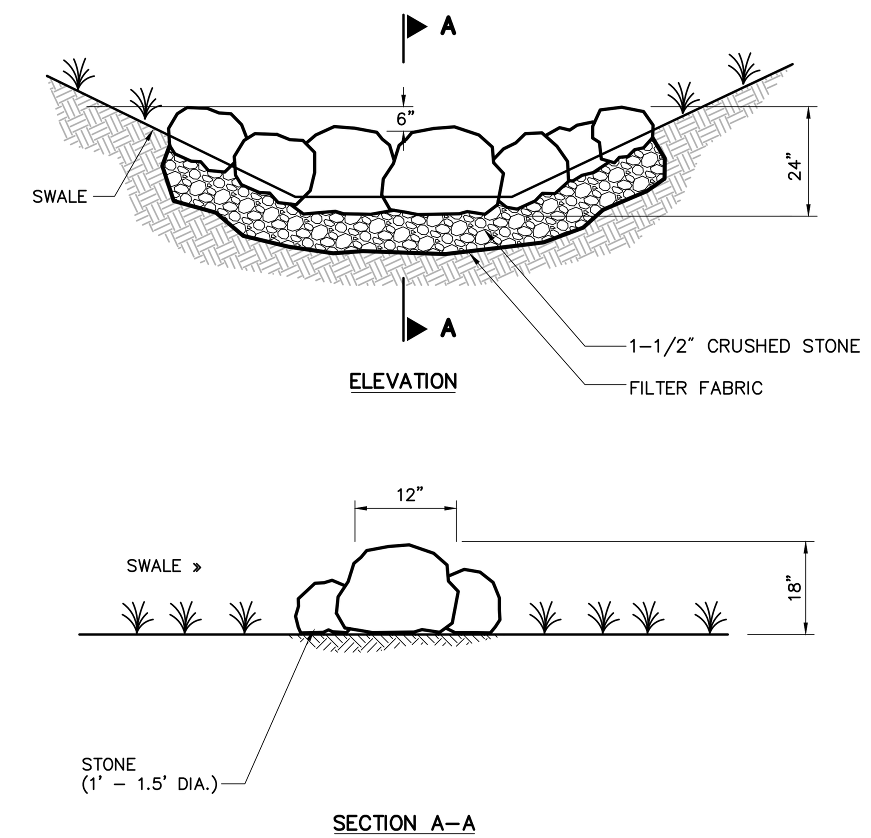


Note:

ADJACENT MATERIALS AND FINISH GRADE VARIES. SEE PLANS.

Placed Boulders
6/08

N.T.S. Source: VHB REV LD_353

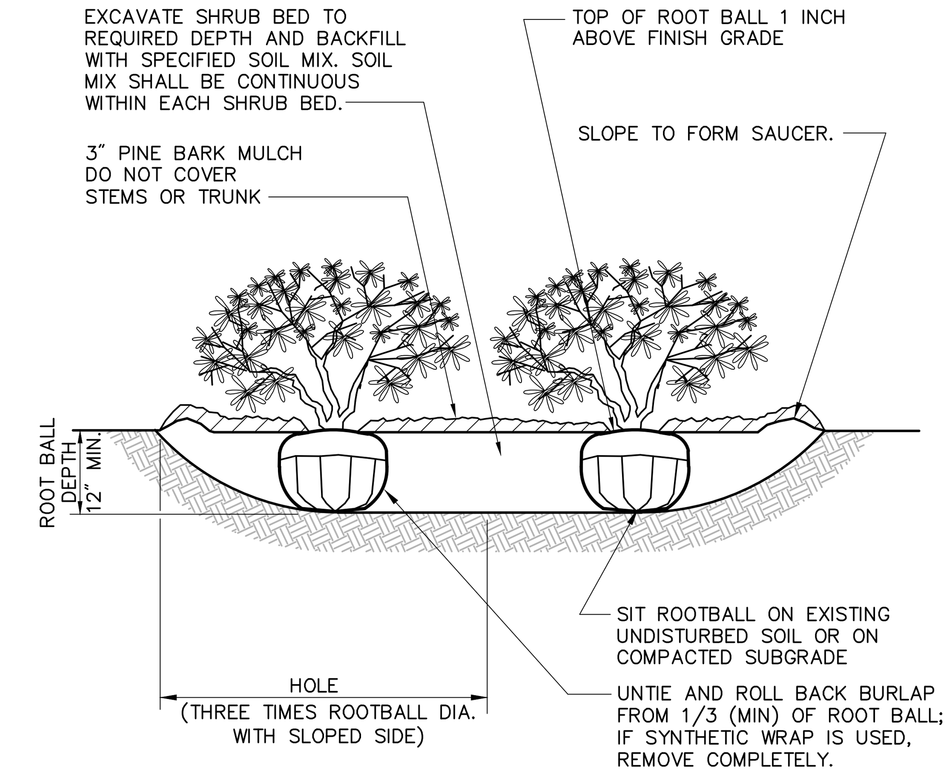


NOTES:

1. STONE CHECKDAM TO BE A PERMANENT STRUCTURE AFTER CONSTRUCTION.

Stone Checkdam
06/17

N.T.S. Source: VHB



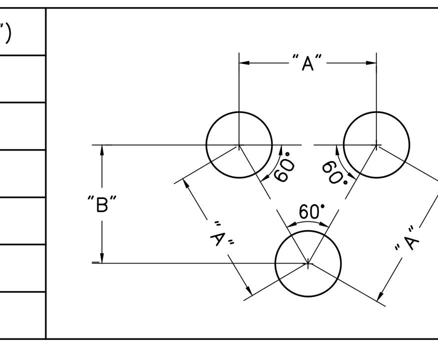
Notes:

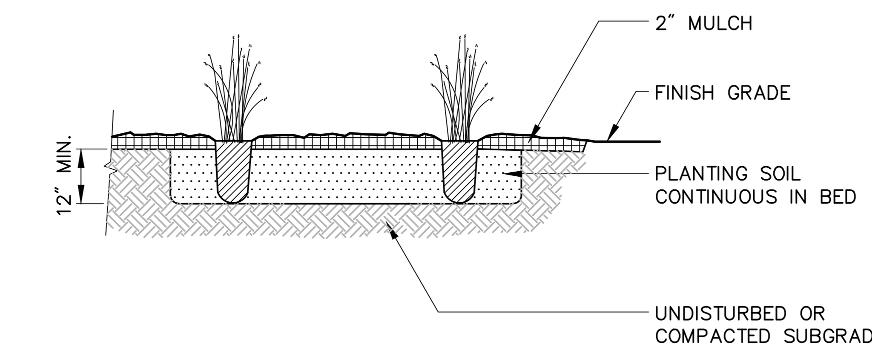
1. LOOSEN ROOTS AT THE OUTER EDGE OF ROOTBALL OF CONTAINER GROWN SHRUBS.

Rain Garden Shrub Bed Planting
6/08

N.T.S. Source: VHB REV LD_601

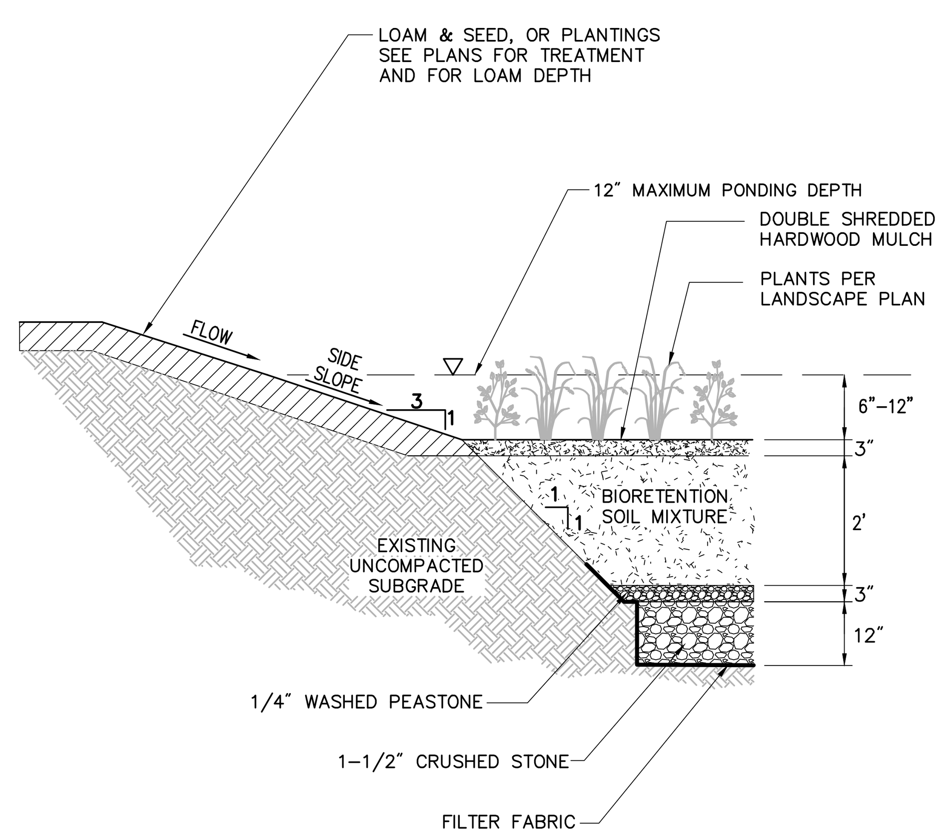
PLANT SPACING ("A")	ROW SPACING ("B")
6 IN. O.C.	5 IN. O.C.
8 IN. O.C.	7 IN. O.C.
10 IN. O.C.	8-1/2 IN. O.C.
12 IN. O.C.	10-1/2 IN. O.C.
15 IN. O.C.	13 IN. O.C.
18 IN. O.C.	16 IN. O.C.





Rain Garden Perennial Plug Planting
11/09

N.T.S. Source: VHB LD_618

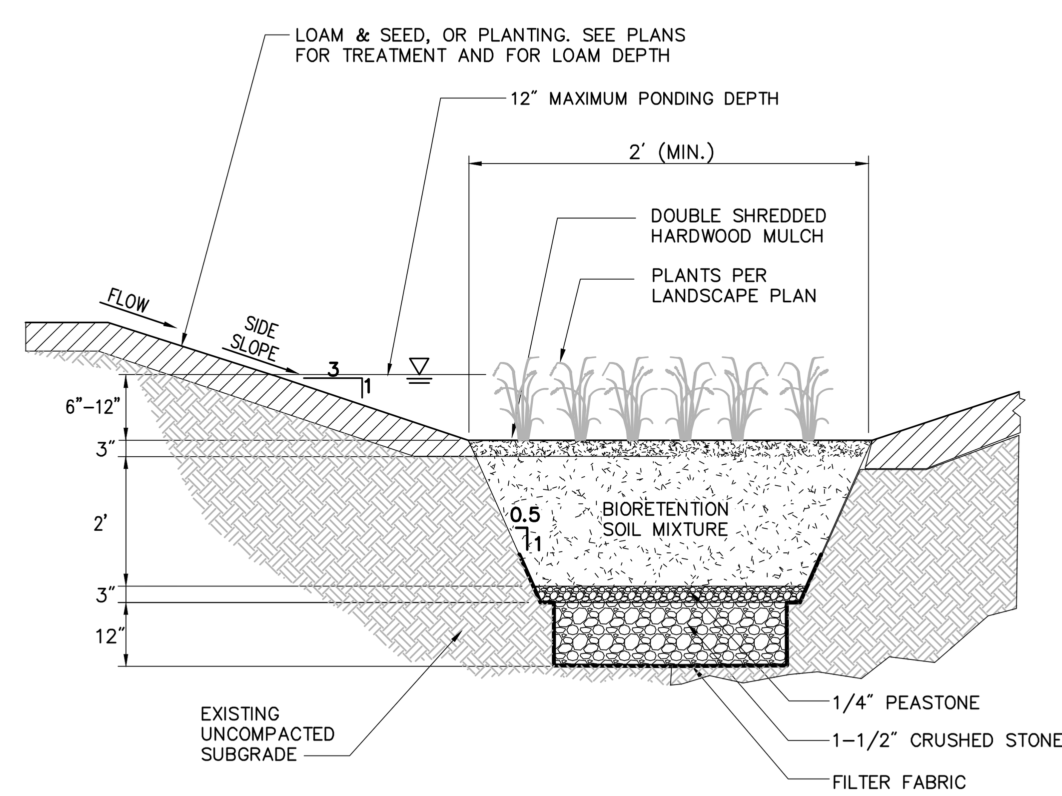


Notes:

1. SURFACE SIDE SLOPES SHALL BE 3:1 MAX. 2% MIN.

Rain Garden
6/08

N.T.S. Source: VHB LD_351

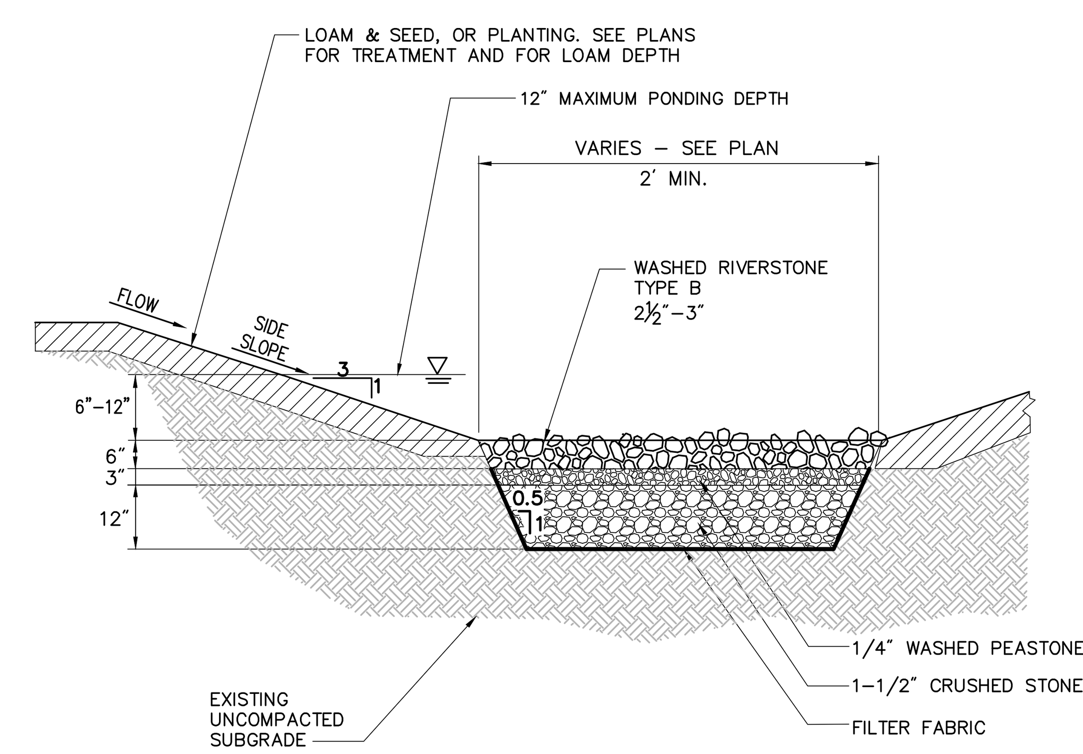


Notes:

1. SURFACE SIDE SLOPES SHALL BE 3:1 MAX. 2% MIN.

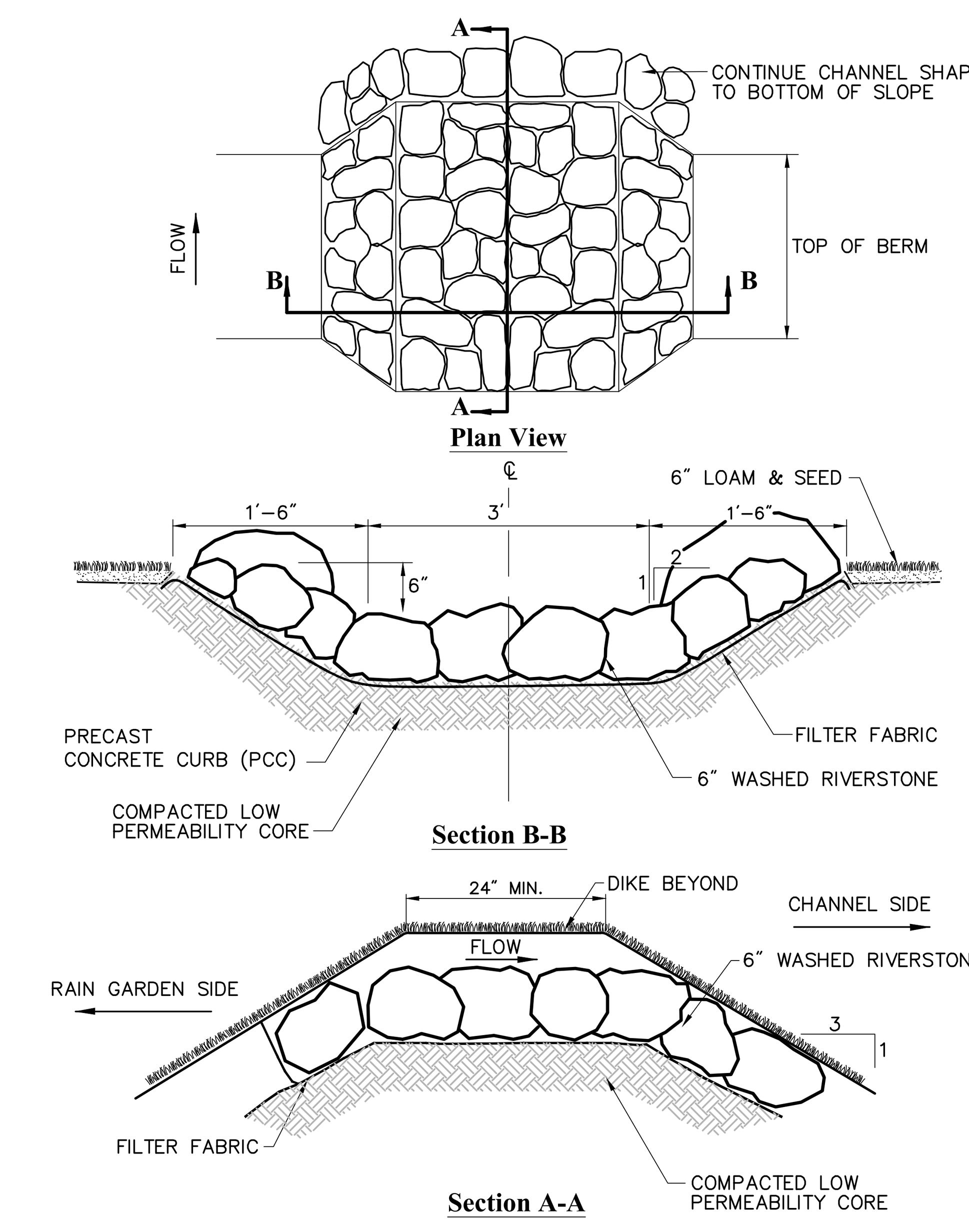
Planted Drainage Swale
6/08

N.T.S. Source: VHB LD_351



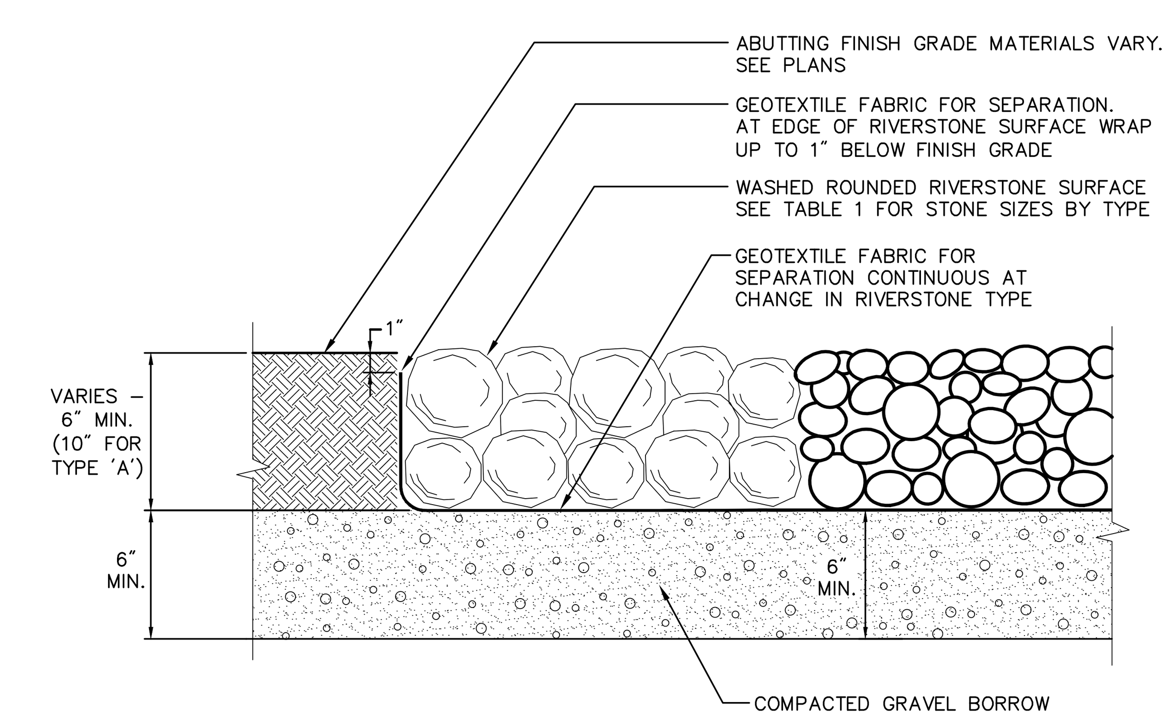
Riverstone Drainage Swale
6/08

N.T.S. Source: VHB LD_351



Overflow Stone Swale
6/08

N.T.S. Source: VHB REV LD_161



WASHED RIVERSTONE SURFACE DIMENSIONAL TABLE 1

WASHED RIVERSTONE TYPE	WASHED ROUNDED RIVERSTONE SIZE
TYPE A	6" –
TYPE B	2½" – 3"
TYPE C	3/8" PEASTONE
TYPE D	1/4" PEASTONE

Washed Riverstone Surface
6/08

N.T.S. Source: VHB LD_351

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Farm Pond Skatepark Rain Garden

Framingham, Massachusetts

No.	Revision	Date	Appvd.
-	AS-BUILT DRAWING	06/29/2018	

Designed by | Checked by

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Drawing Title

Conceptual Details

Drawing Number

L-3

Sheet 4 of 5

Project Number 13484.13

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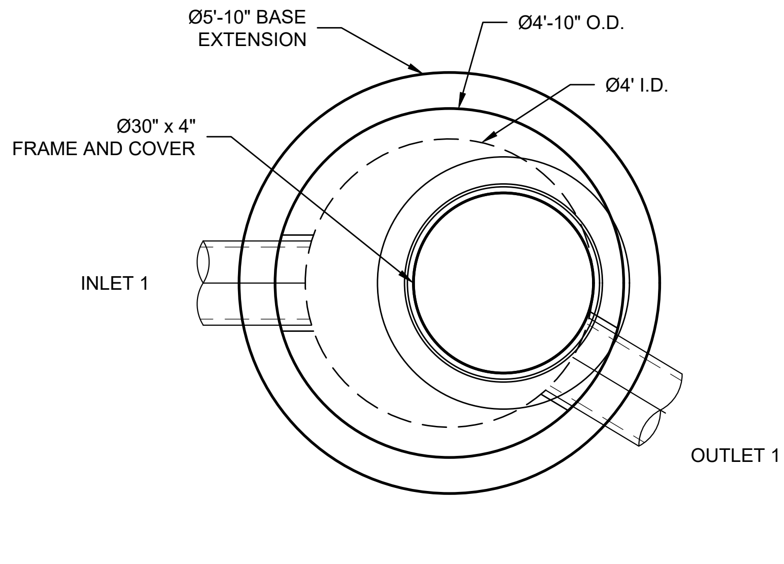
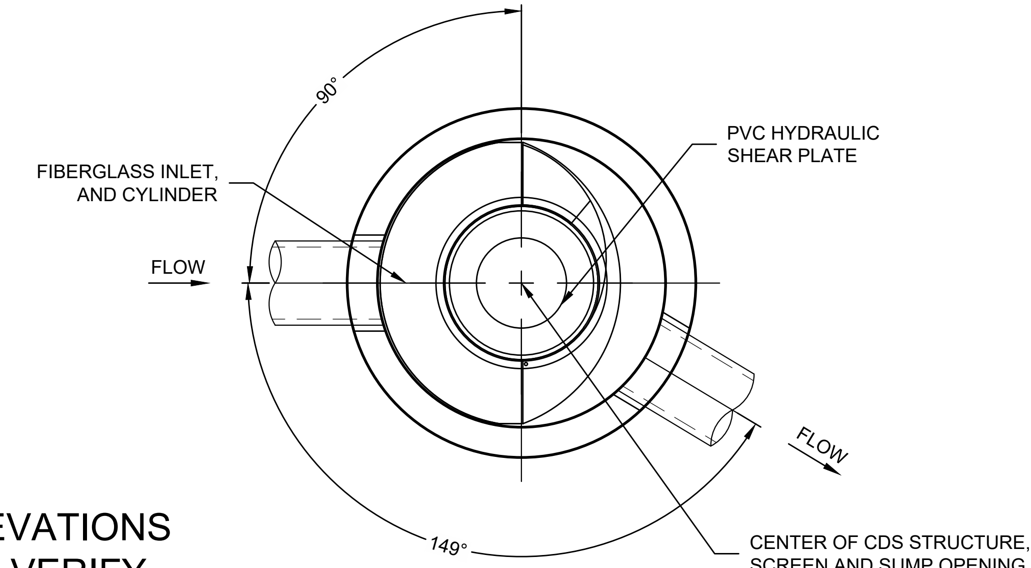
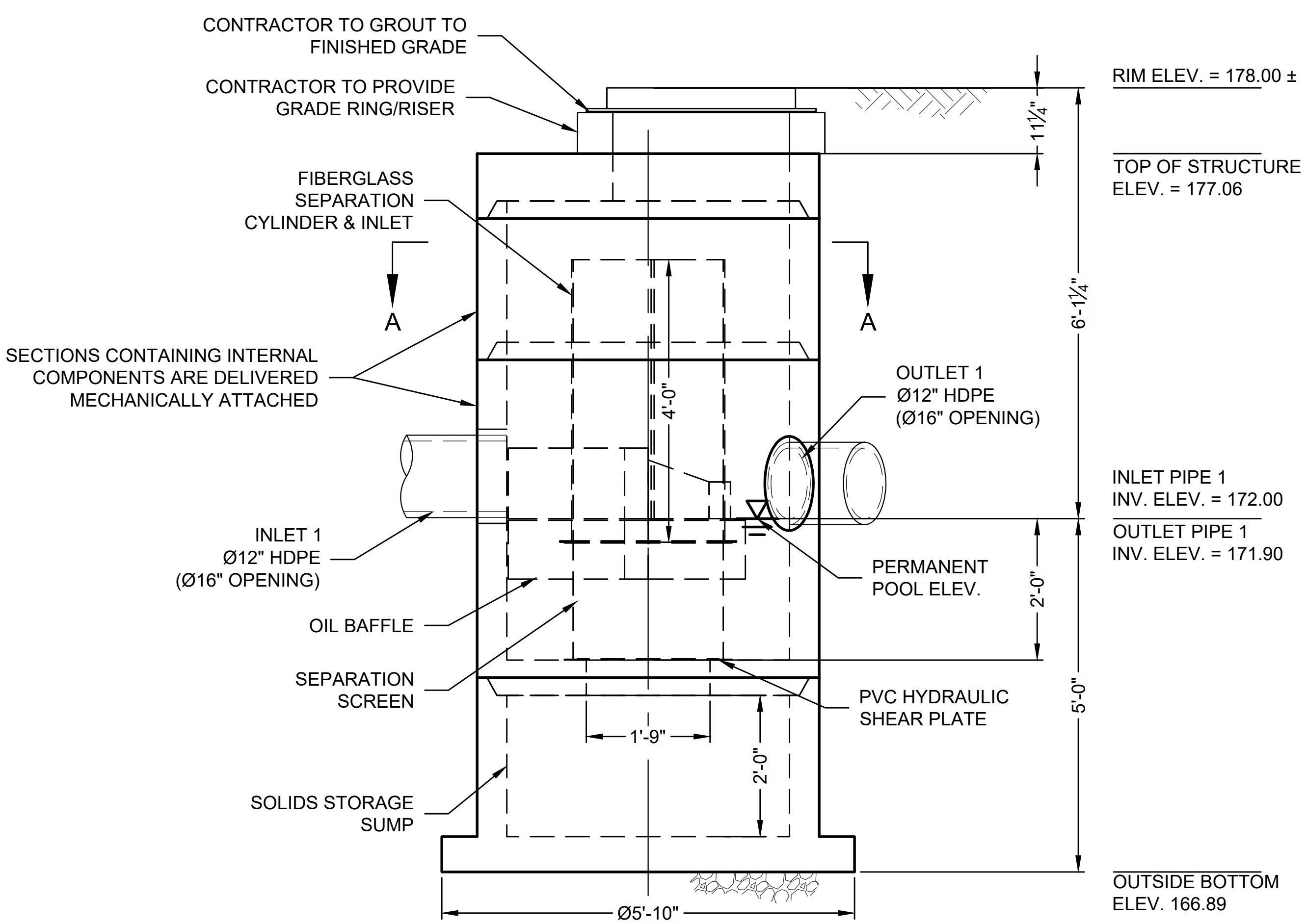


PLAN VIEW

RIM AND INVERT ELEVATIONS
ESTIMATED. PLEASE VERIFY.



SECTION A-A



ELEVATION VIEW

MATERIAL LIST (PROVIDED BY CONTECH)

COUNT	DESCRIPTION	INSTALLED BY
1	FIBERGLASS INLET AND CYLINDER	CONTECH
1	2400 micron, 2' O.D. x 1.67' SEP. SCREEN	CONTECH
1	3/16 INCH PVC HYDRAULIC SHEAR PLATE *	CONTECH
1	SEALANT FOR JOINTS (BY PRECASTER)	CONTRACTOR
1	Ø30" x 4" FRAME & COVER, EJ#41600484, OR EQUIV.	CONTRACTOR

* SEE HYDRAULIC SHEAR PLATE DETAIL

GENERAL NOTES

1. CONTECH TO PROVIDE ALL MATERIALS UNLESS NOTED OTHERWISE.
2. FOR FABRICATION DRAWINGS WITH DETAILED STRUCTURE DIMENSIONS AND WEIGHT, PLEASE CONTACT YOUR CONTECH ENGINEERED SOLUTIONS LLC REPRESENTATIVE. www.ContechES.com
3. CDS WATER QUALITY STRUCTURE SHALL BE IN ACCORDANCE WITH ALL DESIGN DATA AND INFORMATION CONTAINED IN THIS DRAWING. CONTRACTOR TO CONFIRM STRUCTURE MEETS REQUIREMENTS OF PROJECT.
4. STRUCTURE SHALL MEET AASHTO HS-20 LOAD RATING, ASSUMING EARTH COVER OF 0' - 2', AND GROUNDWATER ELEVATION AT, OR BELOW, THE OUTLET PIPE INVERT ELEVATION. ENGINEER OF RECORD TO CONFIRM ACTUAL GROUNDWATER ELEVATION. CASTINGS SHALL MEET AASHTO M306 AND BE CAST WITH THE CONTECH LOGO.
5. IF REQUIRED, PVC HYDRAULIC SHEAR PLATE IS PLACED ON SHELF AT BOTTOM OF SCREEN CYLINDER. REMOVE AND REPLACE AS NECESSARY DURING MAINTENANCE CLEANING.
6. CDS STRUCTURE SHALL BE PRECAST CONCRETE CONFORMING TO ASTM C-478 AND AASHTO LOAD FACTOR DESIGN METHOD.

INSTALLATION NOTES

A. ANY SUB-BASE, BACKFILL DEPTH, AND/OR ANTI-FLOTATION PROVISIONS ARE SITE-SPECIFIC DESIGN CONSIDERATIONS AND SHALL BE SPECIFIED BY ENGINEER OF RECORD.
B. CONTRACTOR TO PROVIDE EQUIPMENT WITH SUFFICIENT LIFTING AND REACH CAPACITY TO LIFT AND SET THE CDS MANHOLE STRUCTURE.
C. CONTRACTOR TO INSTALL JOINT SEALANT BETWEEN ALL STRUCTURE SECTIONS AND ASSEMBLE STRUCTURE.
D. CONTRACTOR TO PROVIDE, INSTALL, AND GROUT INLET AND OUTLET PIPE(S). MATCH PIPE INVERTS WITH ELEVATIONS SHOWN. ALL PIPE CENTERLINES TO MATCH PIPE OPENING CENTERLINES.
E. CONTRACTOR TO TAKE APPROPRIATE MEASURES TO ASSURE UNIT IS WATER TIGHT, HOLDING WATER TO FLOWLINE INVERT MINIMUM. IT IS SUGGESTED THAT ALL JOINTS BELOW PIPE INVERTS ARE GROUTED.

STRUCTURE WEIGHT

APPROXIMATE HEAVIEST PICK = 7000 LBS.
STRUCTURE IS DELIVERED IN 3 PIECES

MAX FOOTPRINT = Ø5'-10"

CONTECH
CONTRACT
DRAWING

ARRO
LAYOUT 1E
2015-4-FGIS
5756 / ARRO10

I:\MERLIN\PROJECT\ACTIVE\620200\620260\620260-10-CDS\DRAWINGS\PRE-620260-10-CDS2015-4 CONFAB.DWG 6/7/2019 9:59 AM

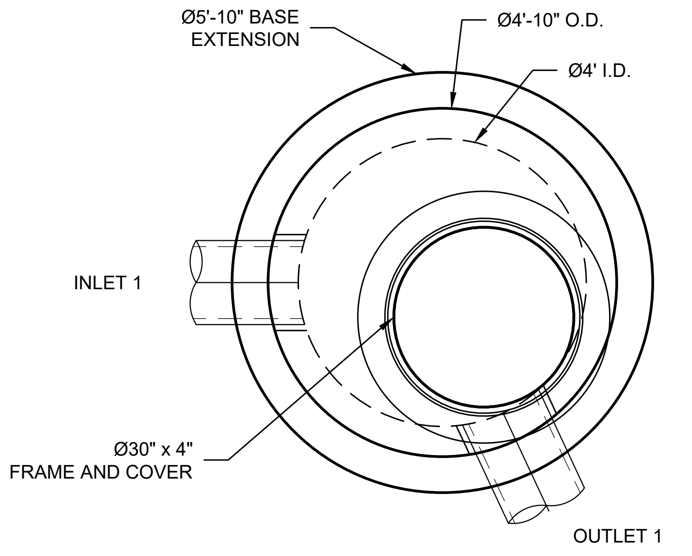
MARK	DATE	REVISION DESCRIPTION	BY

CDS2015-4-C - 620260-10
FOUNTAIN STREET - FRAMINGHAM
FRAMINGHAM, MA
for SYSTEM: WQU #1

CONTECH ENGINEERED SOLUTIONS LLC
www.ContechES.com
2201 W. Royal Lane, Suite 260, Irving, TX 75063
972-590-2000 972-590-2039 FAX

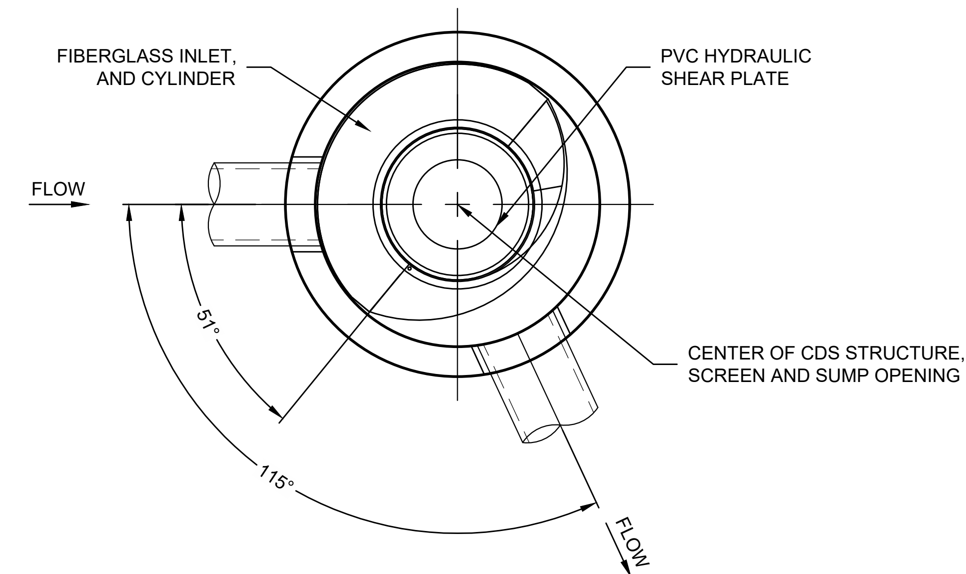
CDS

DATE: 06/03/19	SCALE: 3/8" = 1'-0"
DESIGNED: KMT	DRAWN: JTB
CHECKED: KMC	APPROVED: KMT
PROJECT No.: 620260	SEQUENCE No.: 10
SHEET: 1 OF 1	

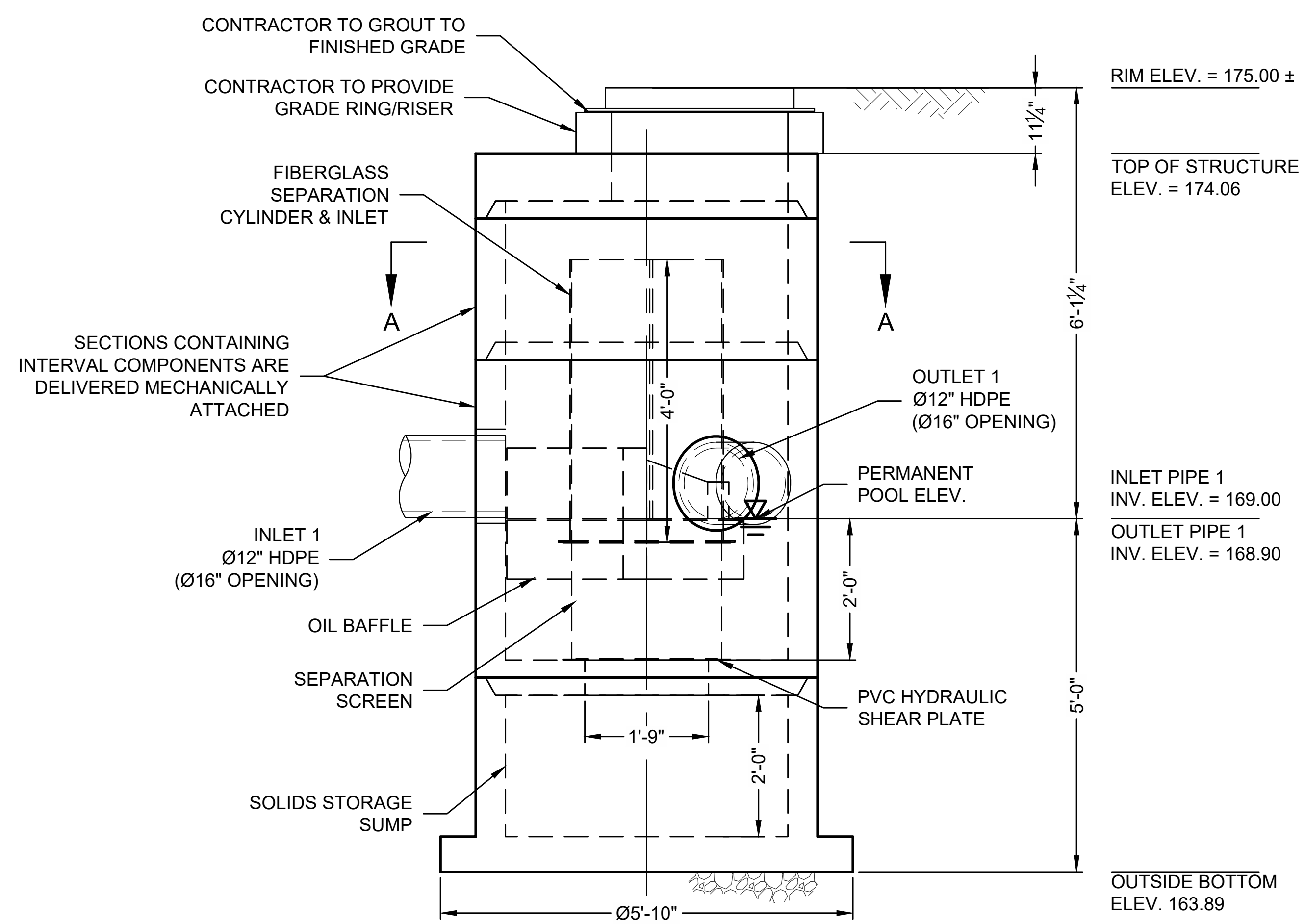


PLAN VIEW

RIM AND PIPE INVERTS ESTIMATED. PLEASE VERIFY.



SECTION A-A



ELEVATION VIEW

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2. FOR FABRICATION DRAWINGS WITH DETAILED STRUCTURE DIMENSIONS AND WEIGHT, PLEASE CONTACT YOUR CONTECH ENGINEERED SOLUTIONS LLC REPRESENTATIVE. www.ContechES.com
3. CDS WATER QUALITY STRUCTURE SHALL BE IN ACCORDANCE WITH ALL DESIGN DATA AND INFORMATION CONTAINED IN THIS DRAWING. CONTRACTOR TO CONFIRM STRUCTURE MEETS REQUIREMENTS OF PROJECT.
4. STRUCTURE SHALL MEET AASHTO HS-20 LOAD RATING, ASSUMING EARTH COVER OF 0' - 2', AND GROUNDWATER ELEVATION AT, OR BELOW, THE OUTLET PIPE INVERT ELEVATION. ENGINEER OF RECORD TO CONFIRM ACTUAL GROUNDWATER ELEVATION. CASTINGS SHALL MEET AASHTO M306 AND BE CAST WITH THE CONTECH LOGO.
5. IF REQUIRED, PVC HYDRAULIC SHEAR PLATE IS PLACED ON SHELF AT BOTTOM OF SCREEN CYLINDER. REMOVE AND REPLACE AS NECESSARY DURING MAINTENANCE CLEANING.
6. CDS STRUCTURE SHALL BE PRECAST CONCRETE CONFORMING TO ASTM C-478 AND AASHTO LOAD FACTOR DESIGN METHOD.

INSTALLATION NOTES

A. ANY SUB-BASE, BACKFILL DEPTH, AND/OR ANTI-FLOTATION PROVISIONS ARE SITE-SPECIFIC DESIGN CONSIDERATIONS AND SHALL BE SPECIFIED BY ENGINEER OF RECORD.
B. CONTRACTOR TO PROVIDE EQUIPMENT WITH SUFFICIENT LIFTING AND REACH CAPACITY TO LIFT AND SET THE CDS MANHOLE STRUCTURE.
C. CONTRACTOR TO INSTALL JOINT SEALANT BETWEEN ALL STRUCTURE SECTIONS AND ASSEMBLE STRUCTURE.
D. CONTRACTOR TO PROVIDE, INSTALL, AND GROUT INLET AND OUTLET PIPE(S). MATCH PIPE INVERTS WITH ELEVATIONS SHOWN. ALL PIPE CENTERLINES TO MATCH PIPE OPENING CENTERLINES.
E. CONTRACTOR TO TAKE APPROPRIATE MEASURES TO ASSURE UNIT IS WATER TIGHT, HOLDING WATER TO FLOWLINE INVERT MINIMUM. IT IS SUGGESTED THAT ALL JOINTS BELOW PIPE INVERTS ARE GROUTED.

STRUCTURE WEIGHT

APPROXIMATE HEAVIEST PICK = 7000 LBS.
STRUCTURE IS DELIVERED IN 3 PIECES

MAX FOOTPRINT = Ø5'-10"

CONTECH
CONTRACT
DRAWING

ARRO
LAYOUT 1E
2015-4-FGIS
5756 / ARRO10

I:\MERLIN\PROJECT\ACTIVE\620200\620260\620260-20-CDS\DRAWINGS\PRE-620260-20-CDS2015-4 CONFAB.DWG 6/7/2019 9:47 AM

MARK	DATE	REVISION DESCRIPTION	BY

CDS2015-4-C - 620260-20
FOUNTAIN STREET - FRAMINGHAM
FRAMINGHAM, MA
for SYSTEM: WQU #2

CONTECH ENGINEERED SOLUTIONS LLC
www.ContechES.com
2201 W. Royal Lane, Suite 260, Irving, TX 75063
972-590-2000 972-590-2039 FAX

DATE: 06/06/19	SCALE: 3/8" = 1'-0"
DESIGNED: KMT	DRAWN: JTB
CHECKED: KMC	APPROVED: KMT
PROJECT No.: 620260	SEQUENCE No.: 20
SHEET: 1 OF 1	

Attachment 5 – Bioretention soil specification

BIORETENTION SOIL MEDIA (BSM) SPECIFICATION

PART 1 - GENERAL

1.1 Bioretention soil media (BSM) should achieve long-term, in-place infiltration and support plant growth while providing pollutant treatment. In order to achieve these goals, the BSM should be a mixture of sand, fines, and compost.

1.2 DELIVERY , STORAGE, AND HANDLING

A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and compliance with state and Federal laws if applicable.

B. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.

PART 2 - PRODUCTS

2.1 MEDIA FOR BIORETENTION SOIL MIX

Bioretention Soil Media shall consist of a homogeneous mixture. The following composition includes the measurements for determining the BSM by volume:

	Sand	Loam	Clay	Compost
Volume	50-60%	20-30%	Less than 5%	10-30%

A. SAND

1. Sand should be thoroughly washed prior to delivery and free of wood, waste, and coatings such as clay, stone dust, carbonate, or any other deleterious material. All aggregate passing the No. 200 sieve size should be non-plastic.

2. Sand for BSM should be analyzed by a qualified lab using #200, #100, #40, #30, #16, #8, #4, and 3/8- inch sieves (ASTM D422 or as approved by municipality) and meet the following gradation:

Sieve #	% Passing
4	100
8	70 - 100
16	40 - 95
30	15 – 70
40	5 – 55
100	0 – 15
200	0 – 5

C. LOAM

1. Loam soil for the BSM shall be free of wood, waste, coating such as stone dust, carbonate, etc., or any other deleterious material. All aggregate passing the No. 200 sieve size shall be non-plastic.
2. Sticks and Roots should be minimized
3. Percentage of Organic Matter: Minimum 4 percent by volume and maximum 8 percent by volume.
4. Soil Reaction: pH of 6 to 7.

D. COMPOSTED MATERIAL

1. Compost should be a well-decomposed, stable, weed-free organic matter source derived from waste materials including yard debris, wood wastes or other organic materials, **not including manure or biosolids**. Compost shall have a dark brown color and a soil-like odor. Compost that is exhibiting a sour or putrid smell, contains recognizable grass or leaves, or is hot (120 degrees Fahrenheit) upon delivery or rewetting is not acceptable.

2. Compost shall meet the following particle size gradation

Sieve Size in	% Passing
1”	100
5/8”	90 - 100
¼”	75 - 100

3. Compost shall comply with the following requirements:
   a. pH of 6 to 8.5
   b. Manufactured inert material (concrete, ceramics, metal, etc.) shall be less than 0.5 percent by dry weight
   c. Minimum organic matter content shall be 35 - 75 percent by dry weight, using TMECC 05.07A “Loss on Ignition Organic Matter Method”.
   d. Soluble salt content less than 4.0 mmhos/cm, tested per TMECC 04.10-A.
   e. Maturity shall be over 80% per TMECC method 05.05-A, “Germination & Vigor”.
   f. Stability shall be 7 or below, per TMECC method 05.08-B “Carbon dioxide Evolution Rate”.
   g. Contain a minimum of 65% by volume recycled plant waste as defined in WAC 173-350-100 as “Yard Waste”, Crop residues” and “Bulking agents”; and 5% to 35% by volume ”post-consumer food waste”.

2.2 MULCH

A. Bioretention Soil shall be covered with 2 inches of clean wood chip meeting the following particle size specification in all areas where slopes are less than 20%.

Sieve Size in	% Passing
1”	70 - 100
5/8”	0 - 50
¼”	0 - 40

B. Contractor shall notify the Engineer to inspect each Bioretention cell prior to placement of wood chip mulch. If any sediment-laden runoff has entered the cell, the Contractor shall remove the top 3 inches of Bioretention soil and replace with Bioretention soil at the Contractor’s expense.

PART 3 - EXECUTION

3.1 GENERAL

A. Place soil media is loose lifts.

B. Compact each blended lift of soil media to 75 percent of maximum Standard Proctor density according to ASTM D 698

C. Finish Grading: Grade soil media to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

D. Verify that no foreign or deleterious material or liquid has been deposited in planting soil. If soil media or subgrade is over compacted, disturbed, or contaminated by foreign or deleterious materials or liquids, remove the soil media and contamination; restore the subgrade as directed by Engineer and replace contaminated soil media with new soil media.

Attachment 6 – Operations & Maintenance manuals

Farm Pond Skate Park Rain Garden

Framingham, MA

PREPARED FOR

City of Framingham
Department of Public Works
110 Western Avenue
Framingham, MA, 01702

PREPARED BY

vhb

101 Walnut Street
PO Box 9151
Watertown, MA 02471
617.924.1770

Revised by Framingham Department of Public Works
July 23, 2018

Long Term Stormwater Operation and Maintenance Measures

Long Term Stormwater Rain Garden Maintenance Measures

BMP Owner: City of Framingham – Parks, Recreation, & Cultural Affairs
Party Responsible for operations & maintenance: City of Framingham – Parks, Recreation, & Cultural Affairs
Source of funding for operations & maintenance: Operations budget from City's General Fund

Rain Gardens require routine maintenance (similar to conventional landscaping maintenance) to ensure that the system both functions well as a stormwater management practice while also maintaining an aesthetic quality compatible with the surrounding park and Farm Pond itself.

The following maintenance program is proposed to ensure the continued effectiveness of the water quality controls at the Farm Pond Skate Park Rain Garden.

GENERAL MAINTENANCE NOTES:

- Fertilizers should not be used in the rain garden or approach swales as excessive nutrients in the topsoil may migrate to the subsoil and be discharged to adjacent surface waters.
- Pesticide/Herbicide Usage – No pesticides are to be used unless a single spot treatment is required for a specific control application.

INITIAL POST-CONSTRUCTION MAINTENANCE:

- During the initial period of vegetation establishment in first year, pruning and weeding are required monthly, to minimize the establishment of undesirable weed species. Weeds and invasive plant species shall be removed by hand.
- Regular watering may be required initially to ensure proper establishment of new vegetation.
- Routinely pick up and remove litter from the rain garden and perimeter landscape areas to avoid the accumulation within the rain garden detention basin.

INITIAL POST-CONSTRUCTION INSPECTIONS:

- The Rain Garden basin should be inspected after every major storm (0.5 inches or greater in 24 hours) for the first few months to ensure proper stabilization and function.

LONG-TERM MAINTENANCE

MONTHLY OR BI-MONTHLY ACTIVITIES:

- Weeds and invasive plant species shall be removed by hand every 6-8 weeks for the first 3 growing seasons.

TWICE PER YEAR ACTIVITIES:

- Plantings, including shrubs, should be inspected twice per year to evaluate health and attended to as necessary.
- Any dead vegetation found after the first year should be replaced.
- Eroded or barren spots should be reseeded to prevent additional erosion and accumulation of sediment.
- Leaf litter and other detritus shall be removed twice per year.

YEARLY ACTIVITIES:

Do not prune or trim perennial plantings and grasses in place in the autumn, but leave for winter interest, winter cover for birds, and to aid the functioning of the rain garden during the winter months. Perennial plantings and grasses may be trimmed at the start of the growing season in March.

- Spring: Remove the previous season's dead growth from grasses and perennials
- Spring: Mulch bioretention basins with hardwood mulch to a depth of 3 inches in spring or as needed. Mulch depth shall not exceed 3 inches. Do not pile mulch on the bases of the trunks of shrubs, but rather hold mulch back 3 inches from all stems.

LONG-TERM INSPECTIONS AND CLEANING

- Rain garden shall be inspected at least twice a year for sediment buildup, for cracking or erosion of side slopes, vegetative conditions, etc. to ensure proper stabilization and function. Important items to check during the inspection include signs of differential settlement, cracking, erosion, leakage in the embankments, condition of rock fill embankment, sediment accumulation, and vegetation health.
- Inspect rain garden and swales after a large storm event to ensure that proper drainage is occurring. Water that remains ponded on the surface of the swale after 72 hours of dry weather could indicate a problem with the infiltrative capacity of the swale, and maintenance should be scheduled.
- During the twice annual inspections, the inflow location should be inspected for clogging. Sediment build up is a common problem where runoff leaves an impervious surface and enters a vegetative or earthen surface. Any built-up sediment over 6 inches should be removed to prevent runoff from bypassing the facility. The overflow dam structure should be inspected to ensure that it is functioning.
- Necessary sediment removal, earth repair, and/or reseeding will be performed upon identification. Sediment should be removed from the basin when sediment accumulates to 6 inches or more frequently if preferred Removal procedures should not take place until the floor of the basin is thoroughly dry. Light equipment, which will not compact the underlying soil, should be used to remove the top 6 inches.

Plant List

- For planting maintenance and replacements, the as-installed plant list is as follows:

Qty. Delivered	Species	Common Name	Category	Size
75	Carex lupulina	Hop Sedge	Grass/Sedge	plug
180	Sporobolus heterolepis	Prairie Dropseed	Grass/Sedge	plug
16	Panicum virgatum 'Heavy Metal'	'Heavy Metal' Northern Switch Grass	Grass/Sedge	2 gal
8	Panicum virgatum 'Shenandoah'	'Shenandoah' Switch Grass	Grass/Sedge	2 gal
38	Schizachyrium scoparium var. scoparium	Little Bluestem	Grass/Sedge	2 qt
3	Aronia arbutifolia	Red Chokeberry	Shrub	2 gal
19	Clethra alnifolia	Coastal Sweet Pepperbush	Shrub	2 gal
9	Ilex glabra 'Densa'	Large Form, Dark Foliage Inkberry	Shrub	2 gal 12-15''
8	Ilex verticillata	Common Winterberry	Shrub	2 gal 18-24"
10	Swida sericea	Red Twig Dogwood	Shrub	2 gal
16	Myrica gale	Sweet Gale	Shrub	2 gal
29	Eutrochium maculatum	Spotted Joe-Pye Weed	Wildflower	1 gal
76	Iris versicolor	Blue Iris, Northern Blue Flag Iris	Wildflower	2 qt
25	Liatris spicata var. spicata	Spike Blazing Star	Wildflower	1 gal
26	Lobelia cardinalis	Cardinal Flower	Wildflower	2 qt
37	Monarda fistulosa var. fistulosa	Wild Bergamot, Basil Bee-Balm	Wildflower	2 qt
77	Rudbeckia fulgida var. fulgida	Black Eyed Susan, Orange Coneflower	Wildflower	2 gal
15	Solidago rugosa 'Fireworks'	'Fireworks' Goldenrod	Wildflower	1 gal
37	Symphyotrichum novae-angliae	New England American-Aster, New England Aster	Wildflower	1 gal
16	Vernonia noveboracensis	New York Ironweed	Wildflower	1 gal
10	Zizia aurea	Common Golden Alexanders	Wildflower	2 qt
730	**TOTAL PLANTS**			

Long Term Best Management Practices Checklist

- The Long-Term BMP Maintenance/Evaluation Checklist is as follows:

CHECKLIST FOR INSPECTION AND MAINTENANCE OF RAIN GARDEN

Framingham Farm Pond Skate Park Rain Garden

Inspection:	Inspection Activity:	Action:
Initial Post-Construction Season:		
Post-rain event Inspection:		
	Inspect rain garden after major rain event (over .5 inches in 24 hours)	Fill in erosion rills, repair any plant and mulch wash-outs
Monthly Inspections (every 4-6 weeks, including autumn clean-up)		
	Review condition of plantings	Weed removal by hand
	Confirm check dams remain in place.	Re-place stones if tossed about.
	Check inlet and out let areas for sediment, leaves and debris	Remove sediment, leaves and debris as needed.
	Review for litter and debris	Litter and debris clean-up throughout rain garden
	Check for bare or eroded adjacent grass areas	Fill in erosion rills, Re-seed bare or eroded adjacent grass areas.
Spring Inspection and Clean-up		
	Confirm plant health (note that grasses and perennials may not green-up until mid-May)	Replace dead, dying, and damaged plants
	Review for litter, debris, and leaf build-up	Litter, debris and leaf clean-up as required

CHECKLIST FOR INSPECTION AND MAINTENANCE OF RAIN GARDEN (continued)

Inspection:	**Inspection Activity:**	**Action:**
Spring Inspection and Clean-up (Con't)		
	Planting maintenance:	Remove spent stems of perennials and grasses, pruning back to top of crown. Do not pull spent stems, but cleanly cut them. Prune broken and/or dying branches from shrubs if not more than 15% of the shrub. If more than 15% of Shrub is in poor health, replace the plant.
	Check for erosion damage	Repair channels if present; re-seed or re-mulch and replant
	Confirm check dams remain in place.	Re-place stones if tossed about.
	Confirm no standing water	Address causes if excessive standing water, and repair surface.
	Review for sediment build-up at inlets and outlets, at check dams, and at low-points	Clean up any sediment build-up noted.
	Note and address any additional issues	
Mid-summer inspections (Perform 2 inspections):		
	Review condition of planting	Weed removal by hand; arrange for replacement of dead plants and plants otherwise in poor condition.
	Note and address any issues	

CHECKLIST FOR INSPECTION AND MAINTENANCE OF RAIN GARDEN (continued)

Inspection:	**Inspection Activity:**	**Action:**
Late Summer/Fall Inspection		
	Confirm plant health	Arrange for replacements of plantings that have failed.
	Litter, debris and leaf clean-up	Litter, debris and leaf clean-up
	Check for erosion damage	Repair channels if present; re-seed or re-mulch and replant
	Confirm check dams remain in place.	Re-place stones if tossed about.
	Confirm no standing water	Address causes if excessive standing water, and repair surface.
	Review for sediment build-up at inlets and outlets, at check dams, and at low-points	Clean up any sediment build-up noted.
	Note and address any issues	Note and address any issues

Figure

Farm Pond Park Completed BMPs

319 NONPOINT SOURCE
POLLUTION GRANT PROGRAM
Farm Pond Green Infrastructure
City of Framingham

N
W E
S

Note: All measurements are approximate.

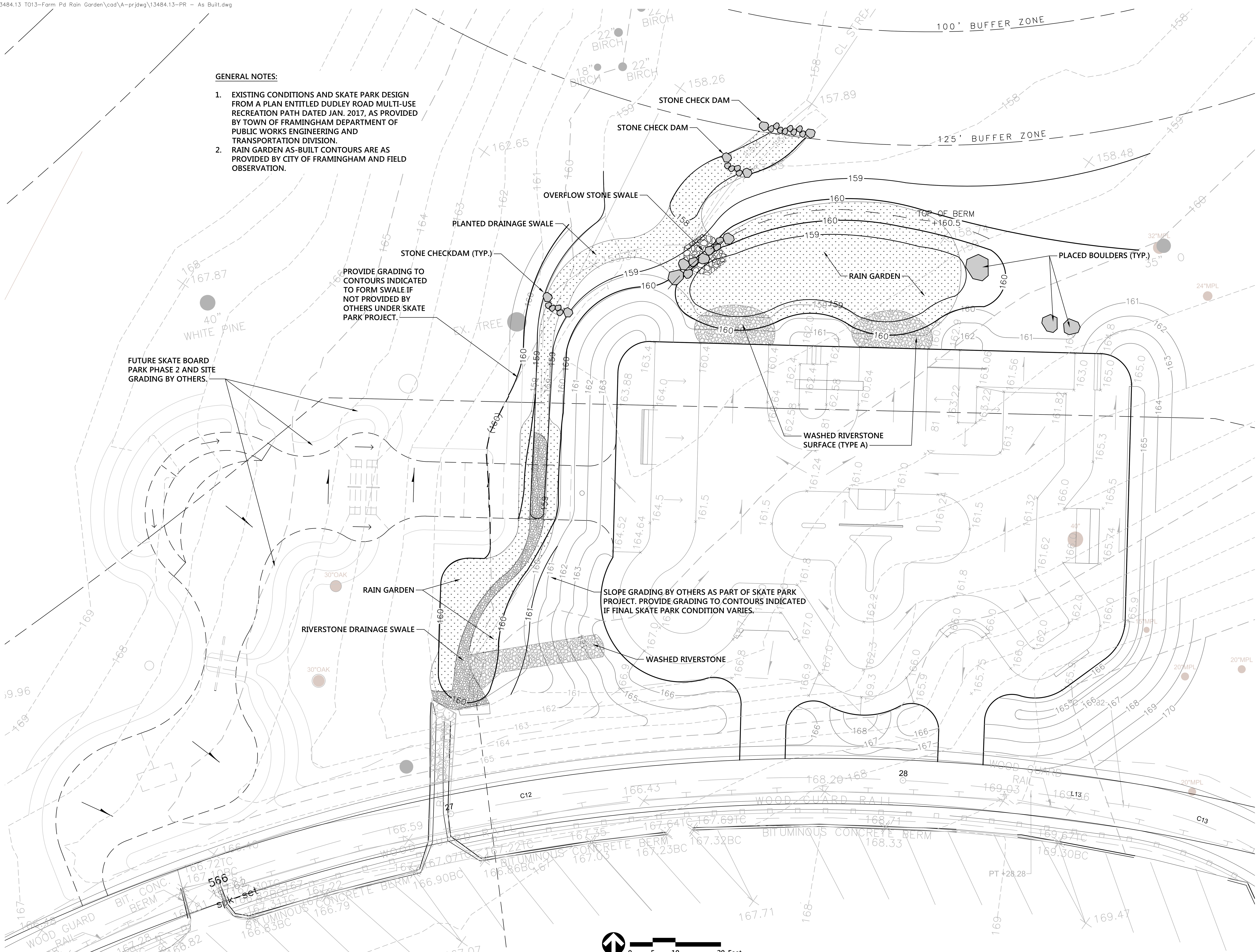
CITY OF FRAMINGHAM
DEPARTMENT OF PUBLIC WORKS
ENGINEERING AND TRANSPORTATION DIVISION
GEOGRAPHIC INFORMATION SYSTEMS MAP

Executive Director | DPW:	Peter A. Sellers
Director | Engineering Division:	William R. Sedewitz
Production Date:	April 2019

\\Vhb\proj\Wat-TE\13484.13 T013-Farm Pd Rain Garden\cad\A-prjdwg\13484.13-PR - As Built.dwg

GENERAL NOTES:

1. EXISTING CONDITIONS AND SKATE PARK DESIGN FROM A PLAN ENTITLED DUDLEY ROAD MULTI-USE RECREATION PATH DATED JAN. 2017, AS PROVIDED BY TOWN OF FRAMINGHAM DEPARTMENT OF PUBLIC WORKS ENGINEERING AND TRANSPORTATION DIVISION.
2. RAIN GARDEN AS-BUILT CONTOURS ARE AS PROVIDED BY CITY OF FRAMINGHAM AND FIELD OBSERVATION.



Saved Friday, June 29, 2018 4:17:01 PM KLYNCH Plotted Friday, June 29, 2018 4:17:39 PM Lynch, Kathleen

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PO Box 9151
Watertown, MA 02471
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LEGEND

- PLACED BOULDERS
- CHECK DAM
- OVERFLOW STONE SWALE
- RIVERSTONE DRAINAGE SWALE
- WASHED RIVERSTONE SURFACE
- SHRUBS / GRASSES / PERENNIALS

Farm Pond Skatepark Rain Garden

Framingham, Massachusetts

No.	Revision	Date	Appvd.
'	AS-BUILT DRAWING	06/29/2018	

Designed by | Checked by

Issued for | Date: July 20, 2017

Drawing Title

Grading and Materials Plan

Drawing Number

L-1

Sheet 2 of 5

Project Number 13484.13

PLANT SCHEDULE

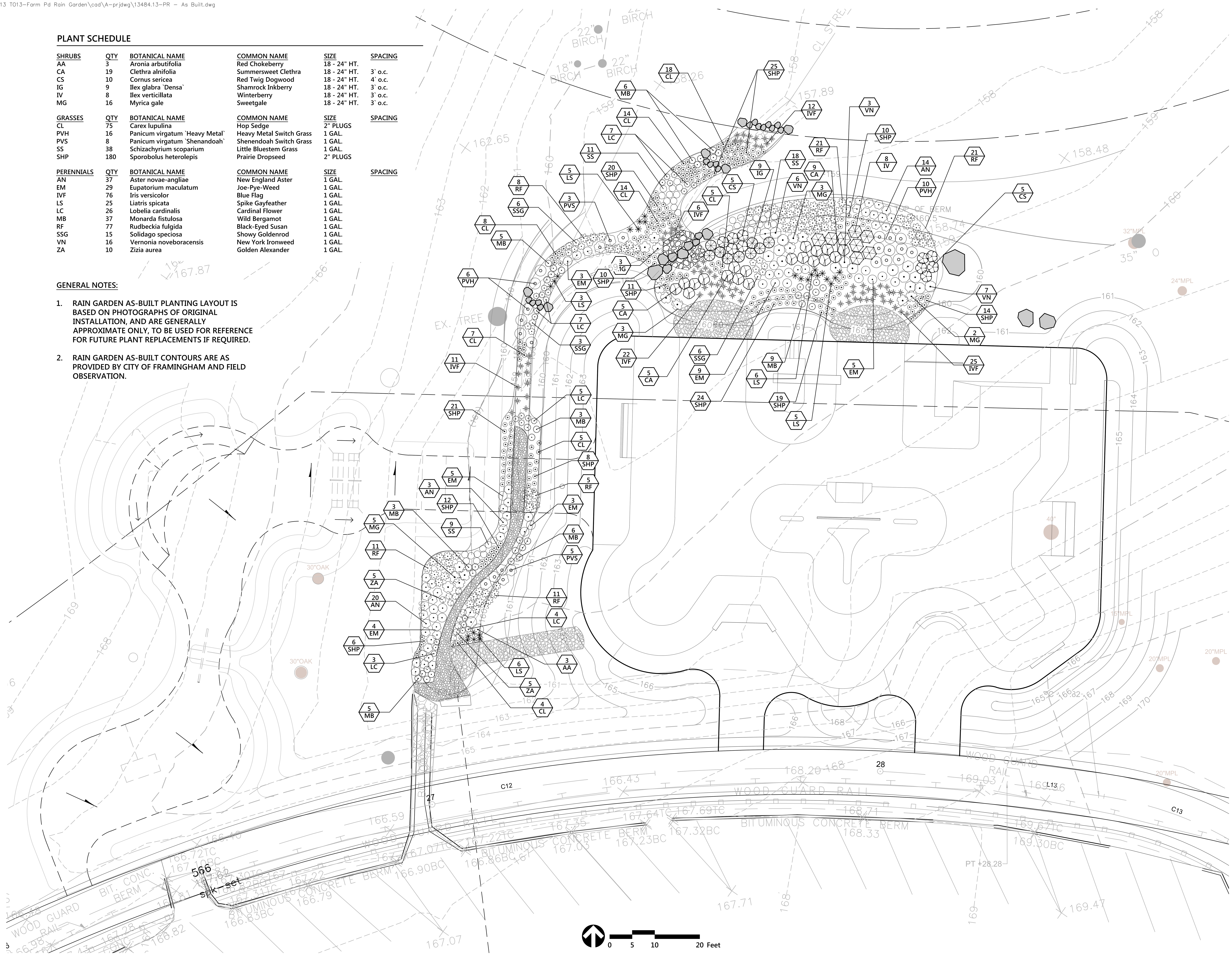
SHRUBS	QTY	BOTANICAL NAME	COMMON NAME	SIZE	SPACING
AA	3	Aronia arbutifolia	Red Chokeberry	18 - 24" HT.	
CA	19	Clethra alnifolia	Summersweet Clethra	18 - 24" HT.	3` o.c.
CS	10	Cornus sericea	Red Twig Dogwood	18 - 24" HT.	4` o.c.
IG	9	Ilex glabra `Densa`	Shamrock Inkberry	18 - 24" HT.	3` o.c.
IV	8	Ilex verticillata	Winterberry	18 - 24" HT.	3` o.c.
MG	16	Myrica gale	Sweetgale	18 - 24" HT.	3` o.c.

GRASSES	QTY	BOTANICAL NAME	COMMON NAME	SIZE	SPACING
CL	75	Carex lupulina	Hop Sedge	2" PLUGS	
PVH	16	Panicum virgatum `Heavy Metal`	Heavy Metal Switch Grass	1 GAL.	
PVS	8	Panicum virgatum `Shenandoah`	Shenendoah Switch Grass	1 GAL.	
SS	38	Schizachyrium scoparium	Little Bluestem Grass	1 GAL.	
SHP	180	Sporobolus heterolepis	Prairie Dropseed	2" PLUGS	

PERENNIALS	QTY	BOTANICAL NAME	COMMON NAME	SIZE	SPACING
AN	37	Aster novae-angliae	New England Aster	1 GAL.	
EM	29	Eupatorium maculatum	Joe-Pye-Weed	1 GAL.	
IVF	76	Iris versicolor	Blue Flag	1 GAL.	
LS	25	Liatris spicata	Spike Gayfeather	1 GAL.	
LC	26	Lobelia cardinalis	Cardinal Flower	1 GAL.	
MB	37	Monarda fistulosa	Wild Bergamot	1 GAL.	
RF	77	Rudbeckia fulgida	Black-Eyed Susan	1 GAL.	
SSG	15	Solidago speciosa	Showy Goldenrod	1 GAL.	
VN	16	Vernonia noveboracensis	New York Ironweed	1 GAL.	
ZA	10	Zizia aurea	Golden Alexander	1 GAL.	

GENERAL NOTES:

1. RAIN GARDEN AS-BUILT PLANTING LAYOUT IS BASED ON PHOTOGRAPHS OF ORIGINAL INSTALLATION, AND ARE GENERALLY APPROXIMATE ONLY, TO BE USED FOR REFERENCE FOR FUTURE PLANT REPLACEMENTS IF REQUIRED.
2. RAIN GARDEN AS-BUILT CONTOURS ARE AS PROVIDED BY CITY OF FRAMINGHAM AND FIELD OBSERVATION.



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Farm Pond Skatepark Rain Garden

Framingham, Massachusetts

No.	Revision	Date	Appvd.
-	AS-BUILT DRAWING	06/29/2018	

Designed by | Checked by

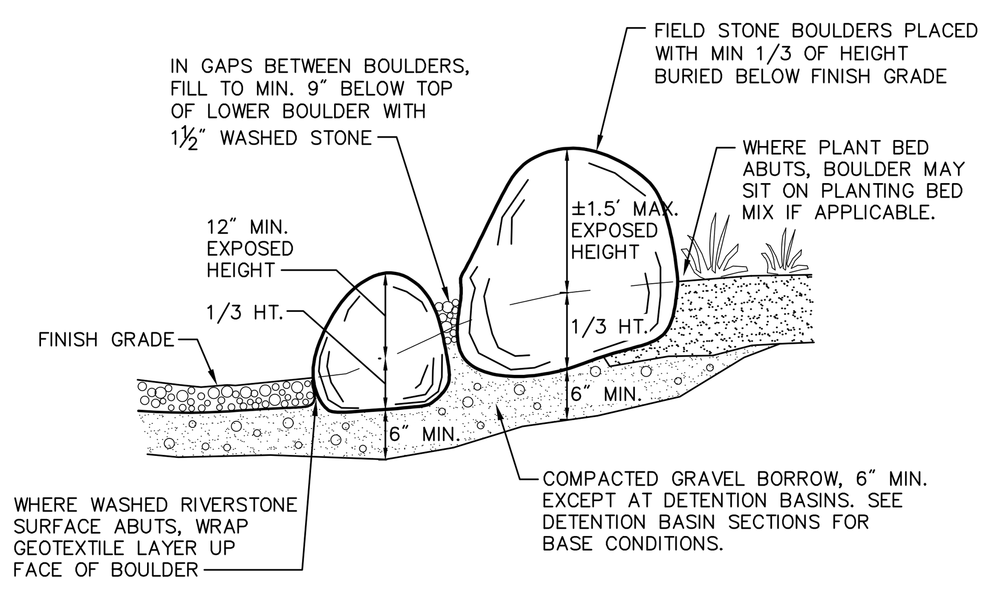
Issued for | Date: July 20, 2017

Drawing Title
Planting Plan

Drawing Number: L-2

Sheet 3 of 5

Project Number: 13484.13



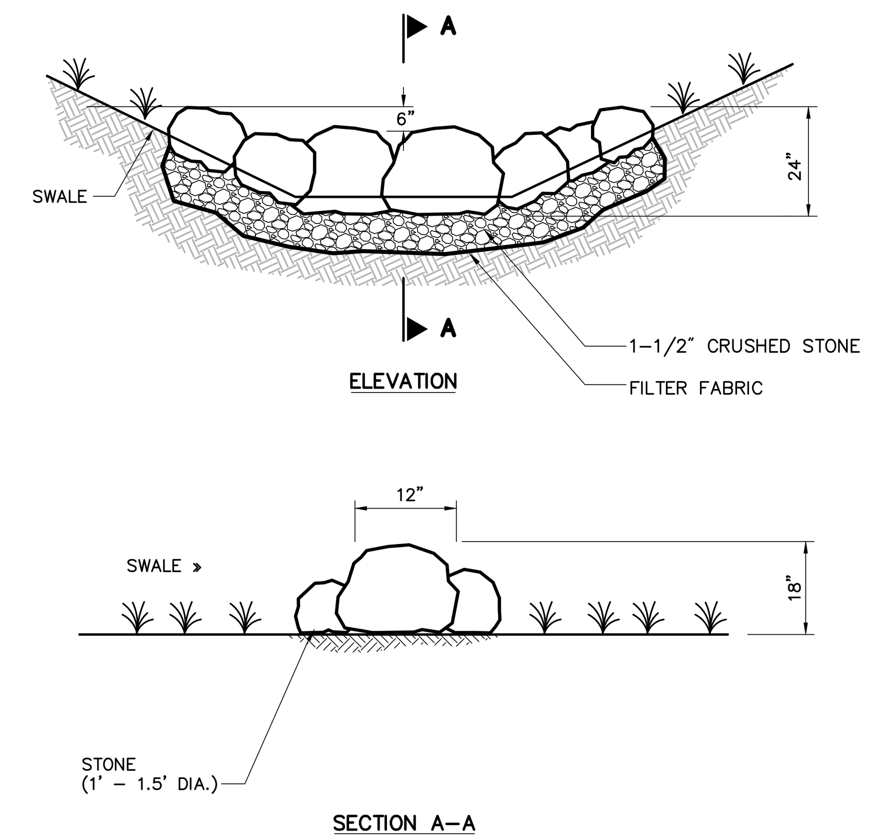
Note:

ADJACENT MATERIALS AND FINISH GRADE VARIES. SEE PLANS.

Placed Boulders

6/08

N.T.S. Source: VHB REV LD_353



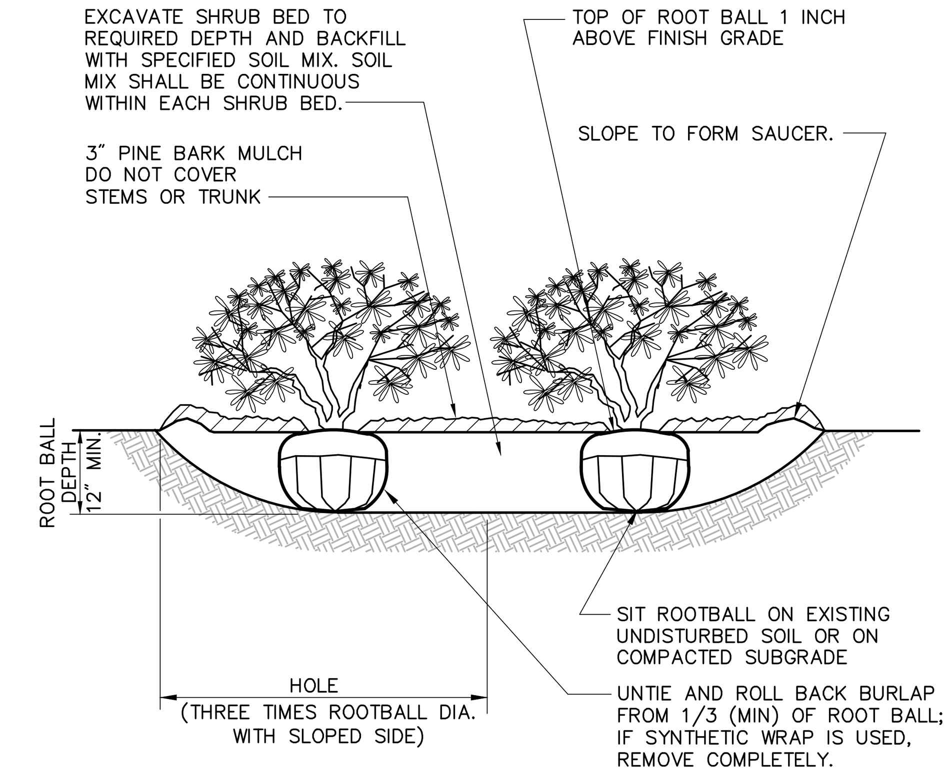
NOTES:

1. STONE CHECKDAM TO BE A PERMANENT STRUCTURE AFTER CONSTRUCTION.

Stone Checkdam

06/17

N.T.S. Source: VHB



Notes:

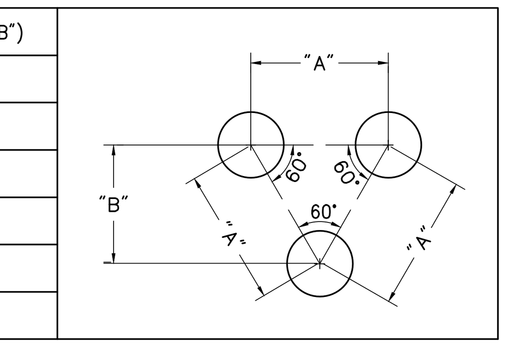
1. LOOSEN ROOTS AT THE OUTER EDGE OF ROOTBALL OF CONTAINER GROWN SHRUBS.

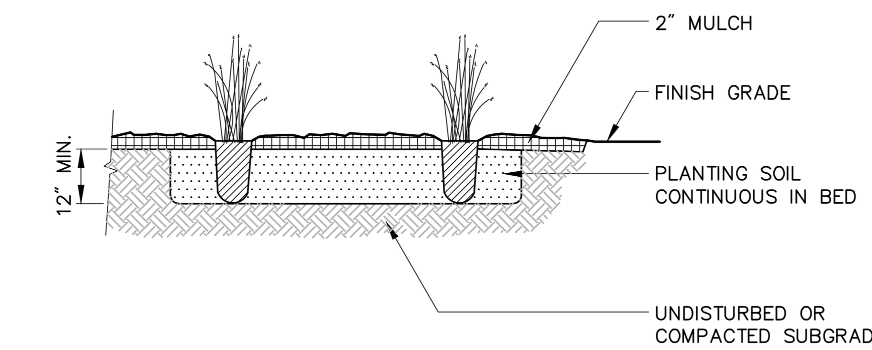
Rain Garden Shrub Bed Planting

6/08

N.T.S. Source: VHB REV LD_601

PLANT SPACING ("A")	ROW SPACING ("B")
6 IN. O.C.	5 IN. O.C.
8 IN. O.C.	7 IN. O.C.
10 IN. O.C.	8-1/2 IN. O.C.
12 IN. O.C.	10-1/2 IN. O.C.
15 IN. O.C.	13 IN. O.C.
18 IN. O.C.	16 IN. O.C.

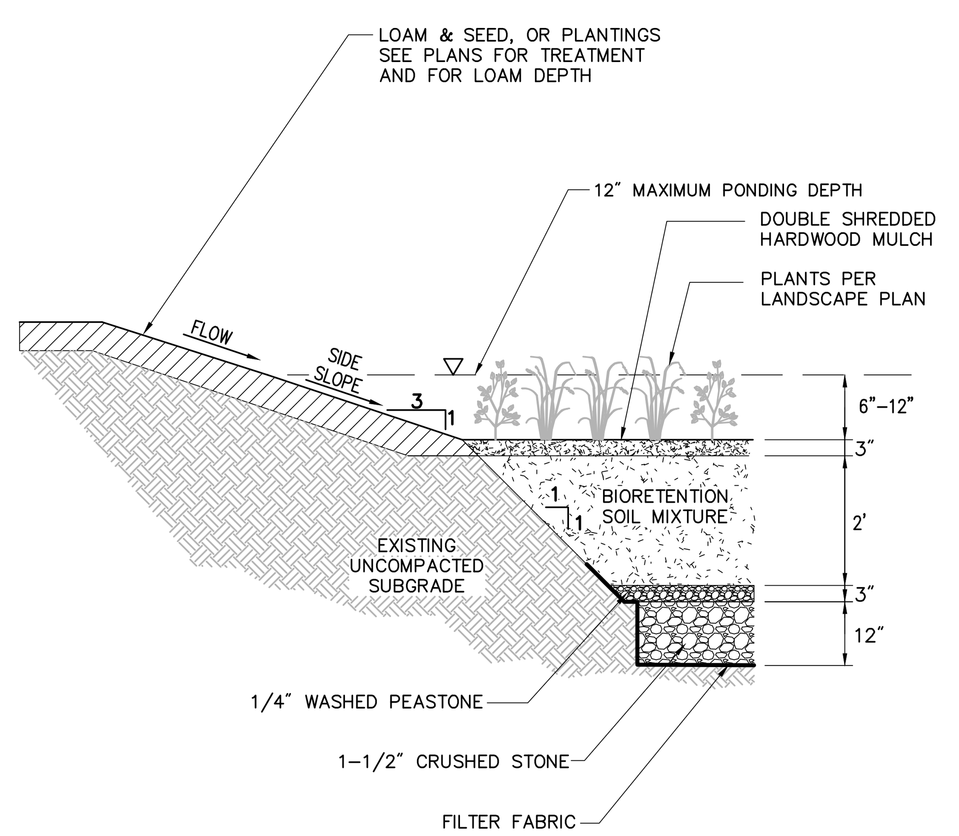




Rain Garden Perennial Plug Planting

11/09

N.T.S. Source: VHB LD_618



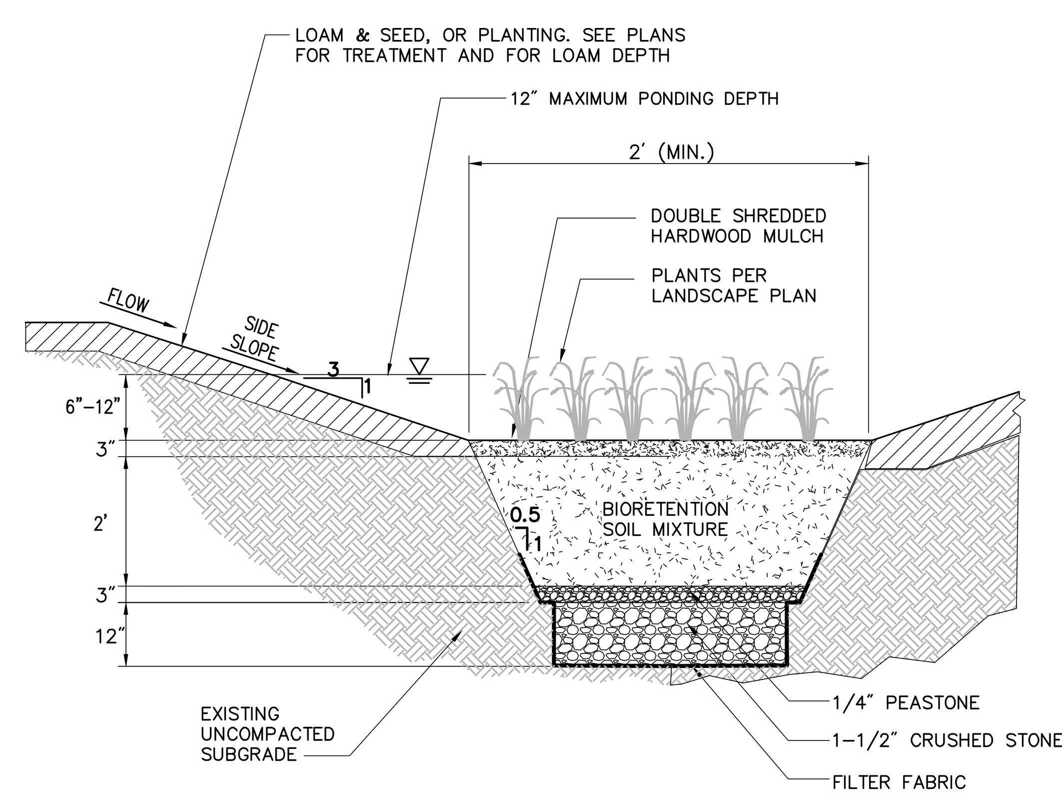
Notes:

1. SURFACE SIDE SLOPES SHALL BE 3:1 MAX. 2% MIN.

Rain Garden

6/08

N.T.S. Source: VHB LD_351



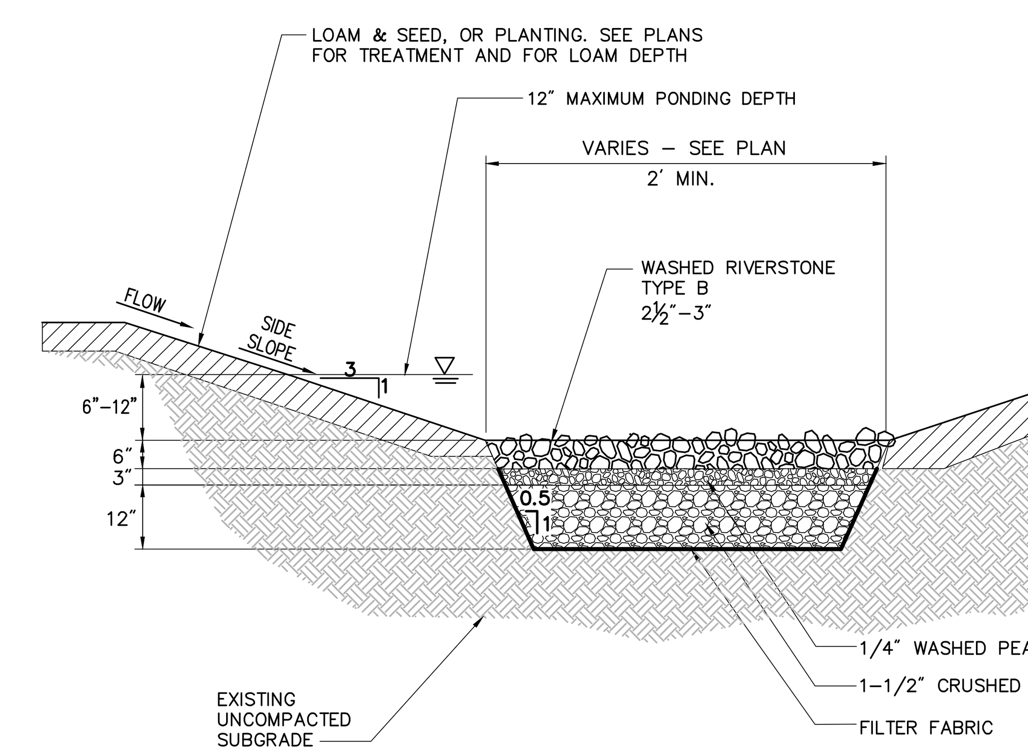
Notes:

1. SURFACE SIDE SLOPES SHALL BE 3:1 MAX. 2% MIN.

Planted Drainage Swale

6/08

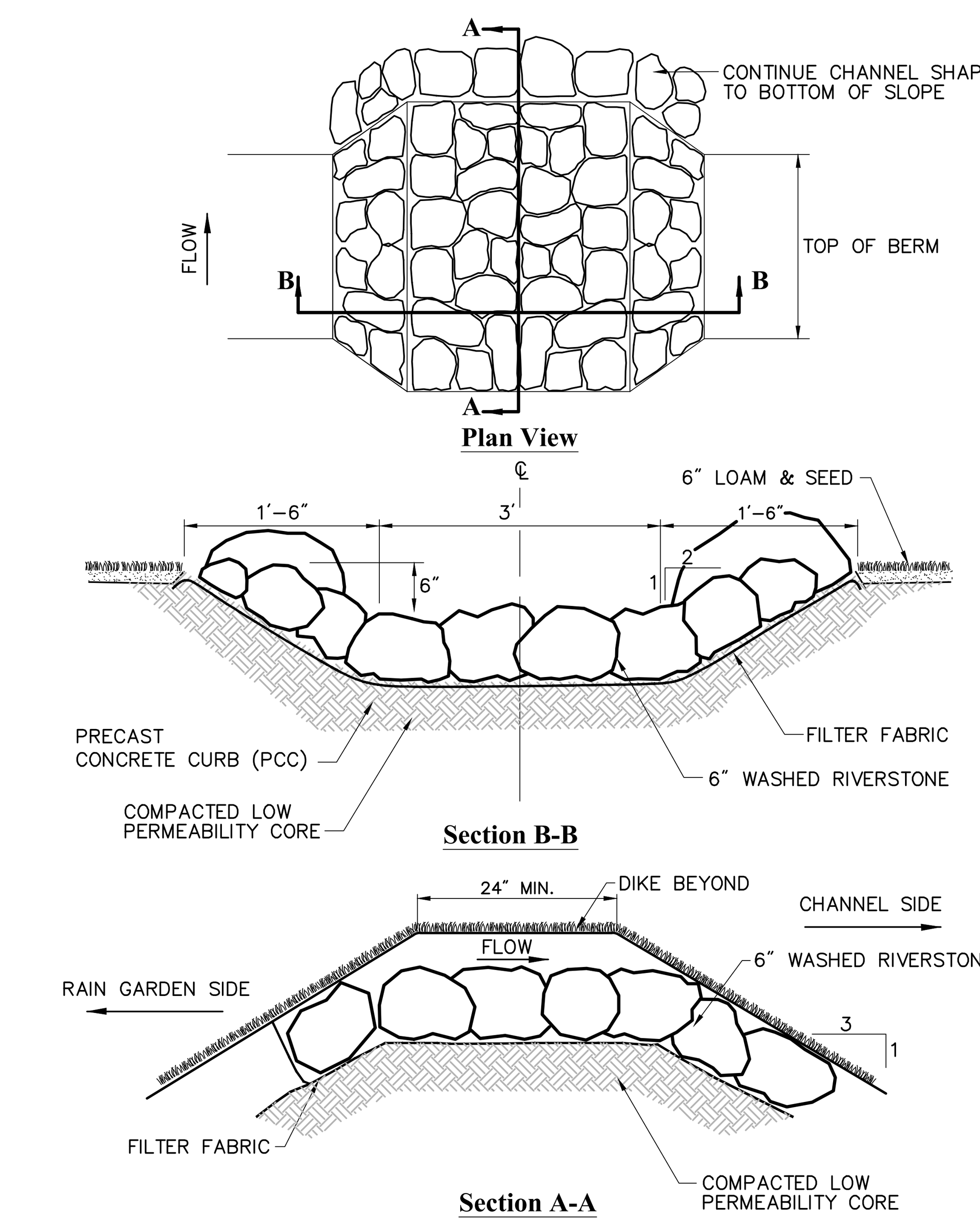
N.T.S. Source: VHB LD_351



Riverstone Drainage Swale

6/08

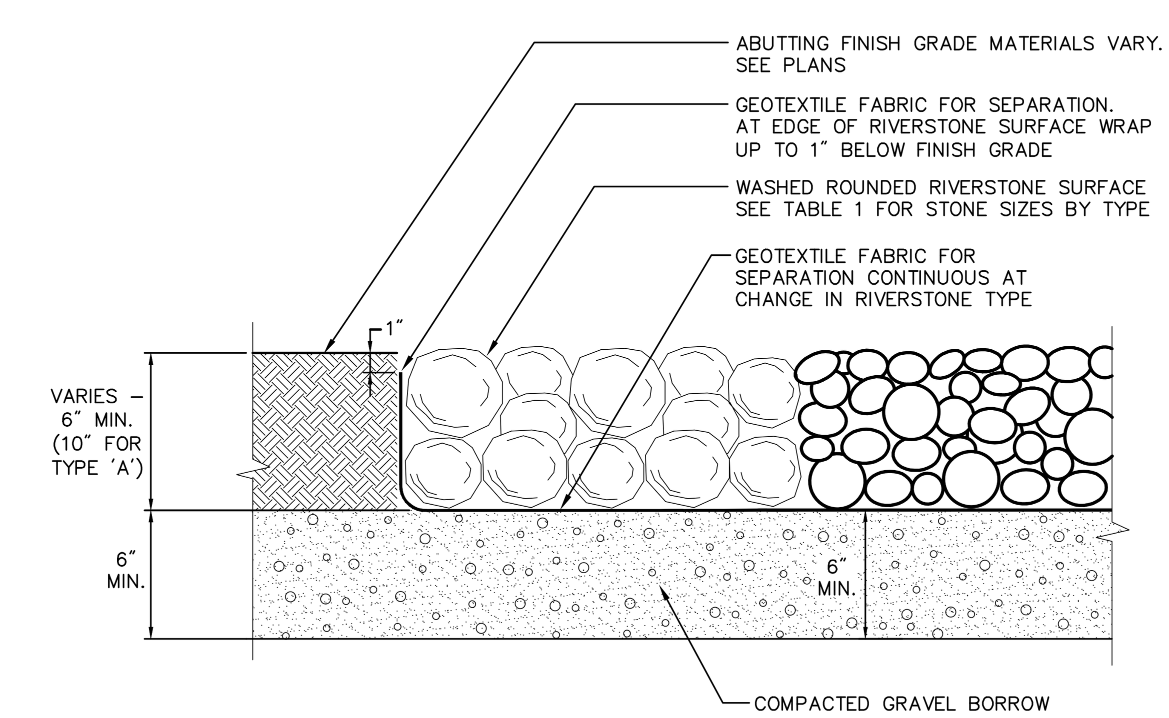
N.T.S. Source: VHB LD_351



Overflow Stone Swale

6/08

N.T.S. Source: VHB REV LD_161



WASHED RIVERSTONE SURFACE DIMENSIONAL TABLE 1

WASHED RIVERSTONE TYPE	WASHED ROUNDED RIVERSTONE SIZE
TYPE A	6" -
TYPE B	2½" - 3"
TYPE C	3/8" PEASTONE
TYPE D	1/4" PEASTONE

Washed Riverstone Surface

6/08

N.T.S. Source: VHB LD_351

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Farm Pond Skatepark Rain Garden

Framingham, Massachusetts

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-	AS-BUILT DRAWING	06/29/2018	

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Issued for Date

July 20, 2017

Drawing Title

Conceptual Details

Drawing Number

L-3

Sheet 4 of 5

Project Number

13484.13

Fountain Street Stormceptor Units

Framingham, MA

Long Term Stormwater Operation and Maintenance Measures

PREPARED FOR

City of Framingham
Department of Public Works
110 Western Avenue
Framingham, MA, 01702

PREPARED BY

City of Framingham
Department of Public Works
110 Western Avenue
Framingham, MA, 01702

June 30, 2019

Long Term Maintenance Measures

BMP Owner: City of Framingham – Department of Public Works
Party Responsible for operations & maintenance: City of Framingham – Department of Public Works
Source of funding for operations & maintenance: Operations budget from City's General Fund

See attached map for location of BMPs.

See attached manufacturers guide titled "CDS Guide: Operation, Design, Performance and Maintenance." The CDS guide includes a schedule for inspections and maintenance, a list of routine and non-routine maintenance tasks.

Figure

Fountain Street Completed BMPs

319 NONPOINT SOURCE POLLUTION GRANT PROGRAM
Farm Pond Green Infrastructure
City of Framingham

N
W E
S

Note: All measurements are approximate.

CITY OF FRAMINGHAM
DEPARTMENT OF PUBLIC WORKS
ENGINEERING AND TRANSPORTATION DIVISION
GEOGRAPHIC INFORMATION SYSTEMS MAP

Executive Director | DPW:	Peter A. Sellers
Director | Engineering Division:	William R. Sedewitz
Production Date:	June 2019

CONTECH®
ENGINEERED SOLUTIONS

CDS Guide
Operation, Design, Performance and Maintenance

CDS®

Using patented continuous deflective separation technology, the CDS system screens, separates and traps debris, sediment, and oil and grease from stormwater runoff. The indirect screening capability of the system allows for 100% removal of floatables and neutrally buoyant material without blinding. Flow and screening controls physically separate captured solids, and minimize the re-suspension and release of previously trapped pollutants. Inline units can treat up to 6 cfs, and internally bypass flows in excess of 50 cfs (1416 L/s). Available precast or cast-in-place, offline units can treat flows from 1 to 300 cfs (28.3 to 8495 L/s). The pollutant removal capacity of the CDS system has been proven in lab and field testing.

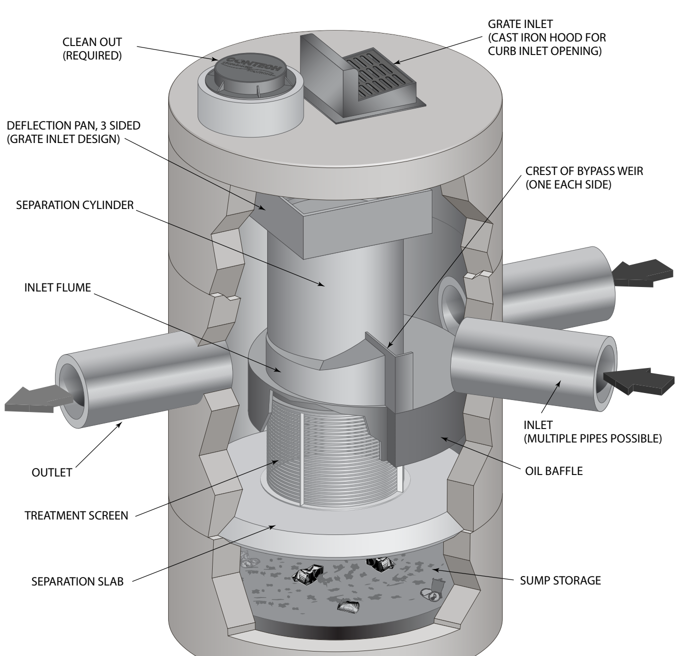
Operation Overview

Stormwater enters the diversion chamber where the diversion weir guides the flow into the unit's separation chamber and pollutants are removed from the flow. All flows up to the system's treatment design capacity enter the separation chamber and are treated.

Swirl concentration and screen deflection force floatables and solids to the center of the separation chamber where 100% of floatables and neutrally buoyant debris larger than the screen apertures are trapped.

Stormwater then moves through the separation screen, under the oil baffle and exits the system. The separation screen remains clog free due to continuous deflection.

During the flow events exceeding the treatment design capacity, the diversion weir bypasses excessive flows around the separation chamber, so captured pollutants are retained in the separation cylinder.



Design Basics

There are three primary methods of sizing a CDS system. The Water Quality Flow Rate Method determines which model size provides the desired removal efficiency at a given flow rate for a defined particle size. The Rational Rainfall Method™ or the and Probabilistic Method is used when a specific removal efficiency of the net annual sediment load is required.

Typically in the Unites States, CDS systems are designed to achieve an 80% annual solids load reduction based on lab generated performance curves for a gradation with an average particle size (d50) of 125 microns (μm). For some regulatory environments, CDS systems can also be designed to achieve an 80% annual solids load reduction based on an average particle size (d50) of 75 microns (μm) or 50 microns (μm).

Water Quality Flow Rate Method

In some cases, regulations require that a specific treatment rate, often referred to as the water quality design flow (WQQ), be treated. This WQQ represents the peak flow rate from either an event with a specific recurrence interval, e.g. the six-month storm, or a water quality depth, e.g. 1/2-inch (13 mm) of rainfall.

The CDS is designed to treat all flows up to the WQQ. At influent rates higher than the WQQ, the diversion weir will direct most flow exceeding the WQQ around the separation chamber. This allows removal efficiency to remain relatively constant in the separation chamber and eliminates the risk of washout during bypass flows regardless of influent flow rates.

Treatment flow rates are defined as the rate at which the CDS will remove a specific gradation of sediment at a specific removal efficiency. Therefore the treatment flow rate is variable, based on the gradation and removal efficiency specified by the design engineer.

Rational Rainfall Method™

Differences in local climate, topography and scale make every site hydraulically unique. It is important to take these factors into consideration when estimating the long-term performance of any stormwater treatment system. The Rational Rainfall Method combines site-specific information with laboratory generated performance data, and local historical precipitation records to estimate removal efficiencies as accurately as possible.

Short duration rain gauge records from across the United States and Canada were analyzed to determine the percent of the total annual rainfall that fell at a range of intensities. US stations' depths were totaled every 15 minutes, or hourly, and recorded in 0.01-inch increments. Depths were recorded hourly with 1-mm resolution at Canadian stations. One trend was consistent at all sites; the vast majority of precipitation fell at low intensities and high intensity storms contributed relatively little to the total annual depth.

These intensities, along with the total drainage area and runoff coefficient for each specific site, are translated into flow rates using the Rational Rainfall Method. Since most sites are relatively small and highly impervious, the Rational Rainfall Method is appropriate. Based on the runoff flow rates calculated for each intensity, operating rates within a proposed CDS system are determined. Performance efficiency curve determined from full scale laboratory tests on defined sediment PSDs is applied to calculate solids removal efficiency. The relative removal efficiency at each operating rate is added to produce a net annual pollutant removal efficiency estimate.

Probabilistic Rational Method

The Probabilistic Rational Method is a sizing program Contech developed to estimate a net annual sediment load reduction for a particular CDS model based on site size, site runoff coefficient, regional rainfall intensity distribution, and anticipated pollutant characteristics.

The Probabilistic Method is an extension of the Rational Method used to estimate peak discharge rates generated by storm events of varying statistical return frequencies (e.g. 2-year storm event). Under the Rational Method, an adjustment factor is used to adjust the runoff coefficient estimated for the 10-year event, correlating a known hydrologic parameter with the target storm event. The rainfall intensities vary depending on the return frequency of the storm event under consideration. In general, these two frequency dependent parameters (rainfall intensity and runoff coefficient) increase as the return frequency increases while the drainage area remains constant.

These intensities, along with the total drainage area and runoff coefficient for each specific site, are translated into flow rates using the Rational Method. Since most sites are relatively small and highly impervious, the Rational Method is appropriate. Based on the runoff flow rates calculated for each intensity, operating rates within a proposed CDS are determined. Performance efficiency curve on defined sediment PSDs is applied to calculate solids removal efficiency. The relative removal efficiency at each operating rate is added to produce a net annual pollutant removal efficiency estimate.

Treatment Flow Rate

The inlet throat area is sized to ensure that the WQQ passes through the separation chamber at a water surface elevation equal to the crest of the diversion weir. The diversion weir bypasses excessive flows around the separation chamber, thus preventing re-suspension or re-entrainment of previously captured particles.

Hydraulic Capacity

The hydraulic capacity of a CDS system is determined by the length and height of the diversion weir and by the maximum allowable head in the system. Typical configurations allow hydraulic capacities of up to ten times the treatment flow rate. The crest of the diversion weir may be lowered and the inlet throat may be widened to increase the capacity of the system at a given water surface elevation. The unit is designed to meet project specific hydraulic requirements.

Performance

Full-Scale Laboratory Test Results

A full-scale CDS system (Model CDS2020-5B) was tested at the facility of University of Florida, Gainesville, FL. This CDS unit was evaluated under controlled laboratory conditions of influent flow rate and addition of sediment.

Two different gradations of silica sand material (UF Sediment & OK-110) were used in the CDS performance evaluation. The particle size distributions (PSDs) of the test materials were analyzed using standard method "Gradation ASTM D-422 "Standard Test Method for Particle-Size Analysis of Soils" by a certified laboratory.

UF Sediment is a mixture of three different products produced by the U.S. Silica Company: "Sil-Co-Sil 106", "#1 DRY" and "20/40 Oil Frac". Particle size distribution analysis shows that the UF Sediment has a very fine gradation (d50 = 20 to 30 μm) covering a wide size range (Coefficient of Uniformity, C averaged at 10.6). In comparison with the hypothetical TSS gradation specified in the NJDEP (New Jersey Department of Environmental Protection) and NJCAT (New Jersey Corporation for Advanced Technology) protocol for lab testing, the UF Sediment covers a similar range of particle size but with a finer d50 (d50 for NJDEP is approximately 50 μm) (NJDEP, 2003).

The OK-110 silica sand is a commercial product of U.S. Silica Sand. The particle size distribution analysis of this material, also included in Figure 1, shows that 99.9% of the OK-110 sand is finer than 250 microns, with a mean particle size (d50) of 106 microns. The PSDs for the test material are shown in Figure 1.

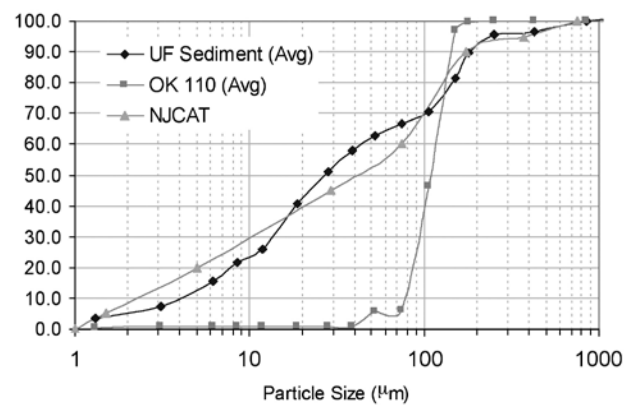


Figure 1. Particle size distributions

Tests were conducted to quantify the performance of a specific CDS unit (1.1 cfs (31.3-L/s) design capacity) at various flow rates, ranging from 1% up to 125% of the treatment design capacity of the unit, using the 2400 micron screen. All tests were conducted with controlled influent concentrations of approximately 200 mg/L. Effluent samples were taken at equal time intervals across the entire duration of each test run. These samples were then processed with a Dekaport Cone sample splitter to obtain representative sub-samples for Suspended Sediment Concentration (SSC) testing using ASTM D3977-97 "Standard Test Methods for Determining Sediment Concentration in Water Samples", and particle size distribution analysis.

Results and Modeling

Based on the data from the University of Florida, a performance model was developed for the CDS system. A regression analysis was used to develop a fitting curve representative of the scattered data points at various design flow rates. This model, which demonstrated good agreement with the laboratory data, can then be used to predict CDS system performance with respect to SSC removal for any particle size gradation, assuming the particles are inorganic sandy-silt. Figure 2 shows CDS predictive performance for two typical particle size gradations (NJCAT gradation and OK-110 sand) as a function of operating rate.

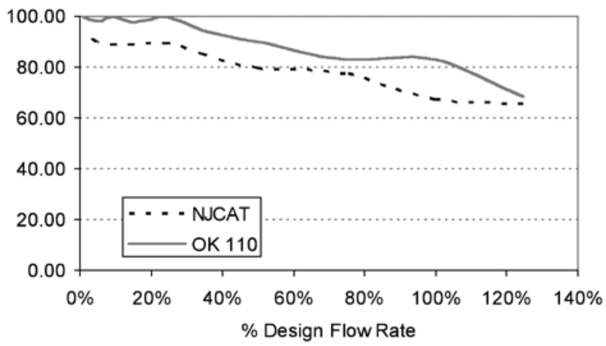


Figure 2. CDS stormwater treatment predictive performance for various particle gradations as a function of operating rate.

Many regulatory jurisdictions set a performance standard for hydrodynamic devices by stating that the devices shall be capable of achieving an 80% removal efficiency for particles having a mean particle size (d50) of 125 microns (e.g. Washington State Department of Ecology — WASDOE - 2008). The model can be used to calculate the expected performance of such a PSD (shown in Figure 3). The model indicates (Figure 4) that the CDS system with 2400 micron screen achieves approximately 80% removal at the design (100%) flow rate, for this particle size distribution (d50 = 125 μm).

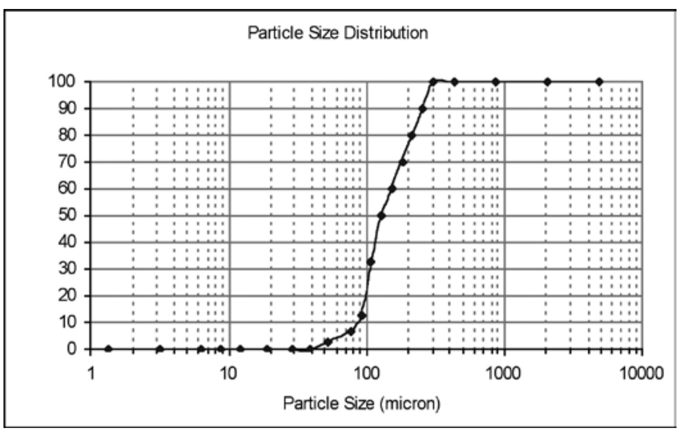


Figure 3. WASDOE PSD

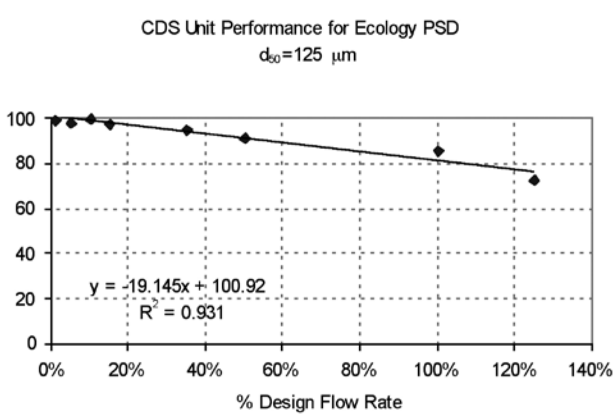


Figure 4. Modeled performance for WASDOE PSD.

Maintenance

The CDS system should be inspected at regular intervals and maintained when necessary to ensure optimum performance. The rate at which the system collects pollutants will depend more heavily on site activities than the size of the unit. For example, unstable soils or heavy winter sanding will cause the grit chamber to fill more quickly but regular sweeping of paved surfaces will slow accumulation.

Inspection

Inspection is the key to effective maintenance and is easily performed. Pollutant transport and deposition may vary from year to year and regular inspections will help ensure that the system is cleaned out at the appropriate time. At a minimum, inspections should be performed twice per year (e.g. spring and fall) however more frequent inspections may be necessary in climates where winter sanding operations may lead to rapid accumulations, or in equipment washdown areas. Installations should also be inspected more frequently where excessive amounts of trash are expected.

The visual inspection should ascertain that the system components are in working order and that there are no blockages or obstructions in the inlet and separation screen. The inspection should also quantify the accumulation of hydrocarbons, trash, and sediment in the system. Measuring pollutant accumulation can be done with a calibrated dipstick, tape measure or other measuring instrument. If absorbent material is used for enhanced removal of hydrocarbons, the level of discoloration of the sorbent material should also be identified

during inspection. It is useful and often required as part of an operating permit to keep a record of each inspection. A simple form for doing so is provided.

Access to the CDS unit is typically achieved through two manhole access covers. One opening allows for inspection and cleanout of the separation chamber (cylinder and screen) and isolated sump. The other allows for inspection and cleanout of sediment captured and retained outside the screen. For deep units, a single manhole access point would allows both sump cleanout and access outside the screen.

The CDS system should be cleaned when the level of sediment has reached 75% of capacity in the isolated sump or when an appreciable level of hydrocarbons and trash has accumulated. If absorbent material is used, it should be replaced when significant discoloration has occurred. Performance will not be impacted until 100% of the sump capacity is exceeded however it is recommended that the system be cleaned prior to that for easier removal of sediment. The level of sediment is easily determined by measuring from finished grade down to the top of the sediment pile. To avoid underestimating the level of sediment in the chamber, the measuring device must be lowered to the top of the sediment pile carefully. Particles at the top of the pile typically offer less resistance to the end of the rod than consolidated particles toward the bottom of the pile. Once this measurement is recorded, it should be compared to the as-built drawing for the unit to determine weather the height of the sediment pile off the bottom of the sump floor exceeds 75% of the total height of isolated sump.

Cleaning

Cleaning of a CDS systems should be done during dry weather conditions when no flow is entering the system. The use of a vacuum truck is generally the most effective and convenient method of removing pollutants from the system. Simply remove the manhole covers and insert the vacuum hose into the sump. The system should be completely drained down and the sump fully evacuated of sediment. The area outside the screen should also be cleaned out if pollutant build-up exists in this area.

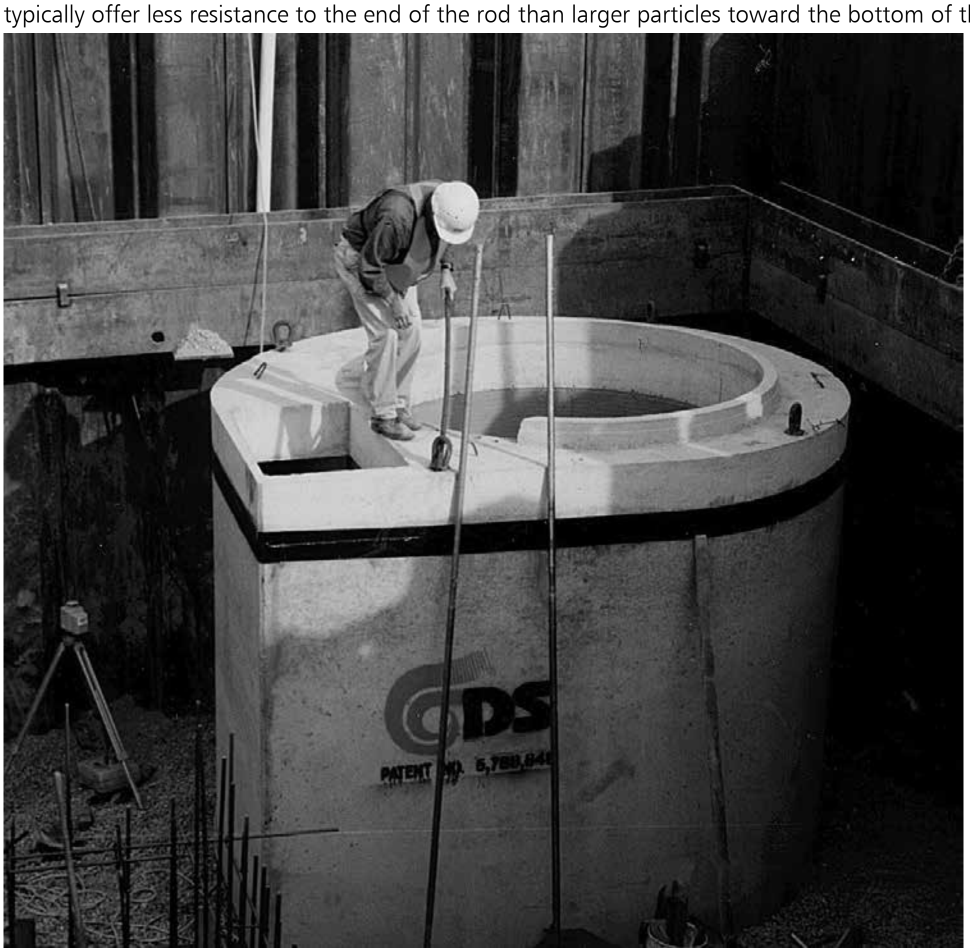
In installations where the risk of petroleum spills is small, liquid contaminants may not accumulate as quickly as sediment. However, the system should be cleaned out immediately in the event of an oil or gasoline spill. Motor oil and other hydrocarbons that accumulate on a more routine basis should be removed when an appreciable layer has been captured. To remove these pollutants, it may be preferable to use absorbent pads since they are usually less expensive to dispose than the oil/water emulsion that may be created by vacuuming the oily layer. Trash and debris can be netted out to separate it from the other pollutants. The screen should be cleaned to ensure it is free of trash and debris.

Manhole covers should be securely seated following cleaning activities to prevent leakage of runoff into the system from above and also to ensure that proper safety precautions have been followed. Confined space entry procedures need to be followed if physical access is required. Disposal of all material removed from the CDS system should be done in accordance with local regulations. In many jurisdictions, disposal of the sediments may be handled in the same manner as the disposal of sediments removed from catch basins or deep sump manholes. Check your local regulations for specific requirements on disposal.

CDS Model	Diameter		Distance from Water Surface to Top of Sediment Pile		Sediment Storage Capacity	
	ft	m	ft	m	y^3	m^3
CDS1515	3	0.9	3.0	0.9	0.5	0.4
CDS2015	4	1.2	3.0	0.9	0.9	0.7
CDS2015	5	1.5	3.0	0.9	1.3	1.0
CDS2020	5	1.5	3.5	1.1	1.3	1.0
CDS2025	5	1.5	4.0	1.2	1.3	1.0
CDS3020	6	1.8	4.0	1.2	2.1	1.6
CDS3025	6	1.8	4.0	1.2	2.1	1.6
CDS3030	6	1.8	4.6	1.4	2.1	1.6
CDS3035	6	1.8	5.0	1.5	2.1	1.6
CDS4030	8	2.4	4.6	1.4	5.6	4.3
CDS4040	8	2.4	5.7	1.7	5.6	4.3
CDS4045	8	2.4	6.2	1.9	5.6	4.3
CDS5640	10	3.0	6.3	1.9	8.7	6.7
CDS5653	10	3.0	7.7	2.3	8.7	6.7
CDS5668	10	3.0	9.3	2.8	8.7	6.7
CDS5678	10	3.0	10.3	3.1	8.7	6.7

Table 1: CDS Maintenance Indicators and Sediment Storage Capacities

Note: To avoid underestimating the volume of sediment in the chamber, carefully lower the measuring device to the top of the sediment pile. Finer silty particles at the top of the pile may be more difficult to feel with a measuring stick. These finer particles typically offer less resistance to the end of the rod than larger particles toward the bottom of the pile.



CDS Inspection & Maintenance Log

CDS Model: ______________________ Location: ______________________

Date	Water depth to sediment[1]	Floatable Layer Thickness[2]	Describe Maintenance Performed	Maintenance Personnel	Comments

1. The water depth to sediment is determined by taking two measurements with a stadia rod: one measurement from the manhole opening to the top of the sediment pile and the other from the manhole opening to the water surface. If the difference between these measurements is less than the values listed in table 1 the system should be cleaned out. **Note: to avoid underestimating the volume of sediment in the chamber, the measuring device must be carefully lowered to the top of the sediment pile**.

2. For optimum performance, the system should be cleaned out when the floating hydrocarbon layer accumulates to an appreciable thickness. In the event of an oil spill, the system should be cleaned immediately.

SUPPORT

- Drawings and specifications are available at www.ContechES.com.
- Site-specific design support is available from our engineers.

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cds_manual 3/17 PDF

Attachment 7 – Rain Garden educational sign

Rain Garden

Did You Know?

Storm water runoff from our lawns and roadways is the major cause of pollution in our ponds and streams.

This cooperative project has been funded in part by the United States Environmental Protection Agency.

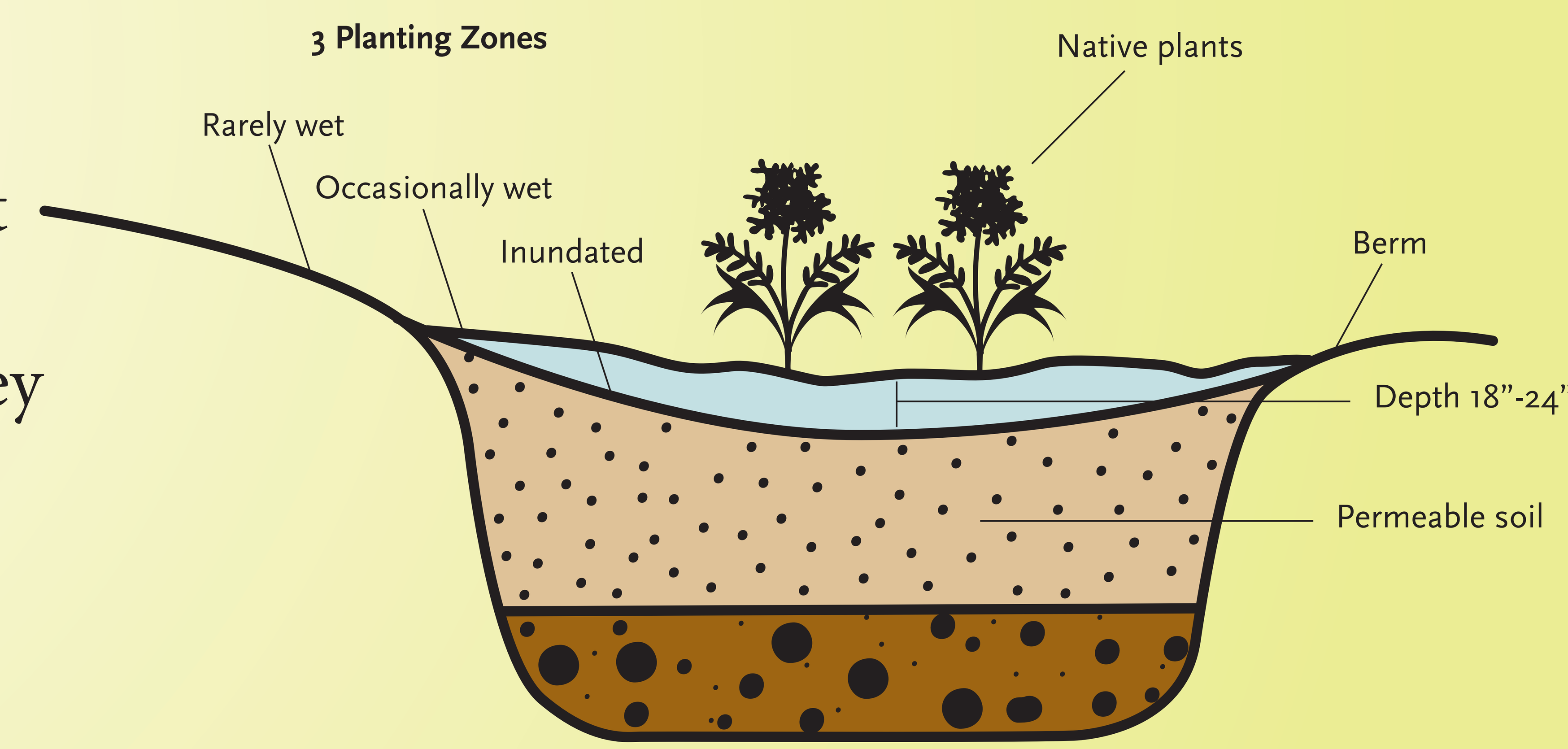
Visit the "Grow" section of www.newenglandwild.org for instructions for creating your own rain garden, from siting to construction to planting.

What Is a Rain Garden?

Rain gardens capture and soak up the rain. A rain garden is a shallow basin, filled with moisture-loving plants, that collects rainwater and filters it into the ground water below. Rain gardens can be located under downspouts, at the edges of driveways, or anywhere that might capture water.

Why a Rain Garden?

Rain gardens enable us to think globally and act locally. They improve our environment by preventing pollutants like fertilizers and pesticides from running into waterways. As they slow the flow of storm water, they prevent erosion and allow plants and soil to act as natural filters, releasing water gradually to recharge local aquifers.



Rain Garden Cross-section

Turtlehead (*Chelone glabra*)
by George Lienau

Cardinal flower (*Lobelia cardinalis*)
by Arieh Tal

Beautiful, Green, and Functional

Landscaping your rain garden with native plants will create habitat for birds, butterflies, and beneficial insects. Easy-to-grow plants like cardinal flower, iris versicolor, and alum-root add form and color to the rain garden, from the wettest section in the middle to the drier sections on the rim.

Attachment 8 – Signed Statement

August 7, 2019

Project Final Report
Farm Pond Green Infrastructure BMPs
319 Nonpoint Source Pollution Grant Program
Project Number: 17-02-319

To Whom It May Concern,

The information provided in the City of Framingham's Project Final Report, Farm Pond Green Infrastructure BMPs, 319 Nonpoint Source Pollution Grant Program, Project Number: 17-02-319 was prepared to the best of the City's knowledge. Estimations in this report were determined using the appropriate estimation model(s) and applied according to the procedures prescribed for the model. To the best of my knowledge these are reasonable estimates using appropriate methods. Documentation is kept on file by the grantee and is available for review by MassDEP/EPA.

Sincerely,

Mary Ellen Kelley
Chief Financial Officer
City of Framingham